US008676104B2

(12) **United States Patent**
Yoshikawa et al.

(10) **Patent No.: US 8,676,104 B2**
(45) **Date of Patent: Mar. 18, 2014**

(54) **FIXING DEVICE AND IMAGE FORMING APPARATUS**

(75) Inventors: **Masaaki Yoshikawa**, Tokyo (JP); **Tetsuo Tokuda**, Kanagawa (JP); **Yutaka Ikebuchi**, Kanagawa (JP); **Takuya Seshita**, Kanagawa (JP); **Hiroshi Yoshinaga**, Chiba (JP); **Hajime Gotoh**, Kanagawa (JP); **Yoshiki Yamaguchi**, Kanagawa (JP); **Toshihiko Shimokawa**, Kanagawa (JP); **Kenji Ishii**, Kanagawa (JP); **Takahiro Imada**, Kanagawa (JP); **Naoki Iwaya**, Tokyo (JP); **Yuji Arai**, Kanagawa (JP); **Arinobu Yoshiura**, Kanagawa (JP); **Hiromasa Takagi**, Tokyo (JP); **Ippei Fujimoto**, Kanagawa (JP)

(73) Assignee: **Ricoh Company, Ltd.**, Tokyo (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 58 days.

(21) Appl. No.: **13/315,581**

(22) Filed: **Dec. 9, 2011**

(65) **Prior Publication Data**

US 2012/0155935 A1 Jun. 21, 2012

(30) **Foreign Application Priority Data**

Dec. 17, 2010 (JP) 2010-282123
Dec. 20, 2010 (JP) 2010-282692

(51) **Int. Cl.**
G03G 15/20 (2006.01)

(52) **U.S. Cl.**
USPC **399/329**

(58) **Field of Classification Search**
USPC 399/329
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,628,916	B2	9/2003	Yasui et al.
6,636,709	B2	10/2003	Furukawa et al.
6,778,790	B2	8/2004	Yoshinaga et al.
6,778,804	B2	8/2004	Yoshinaga et al.

(Continued)

FOREIGN PATENT DOCUMENTS

JP	4-44075	2/1992
JP	8-262903	10/1996

(Continued)

OTHER PUBLICATIONS

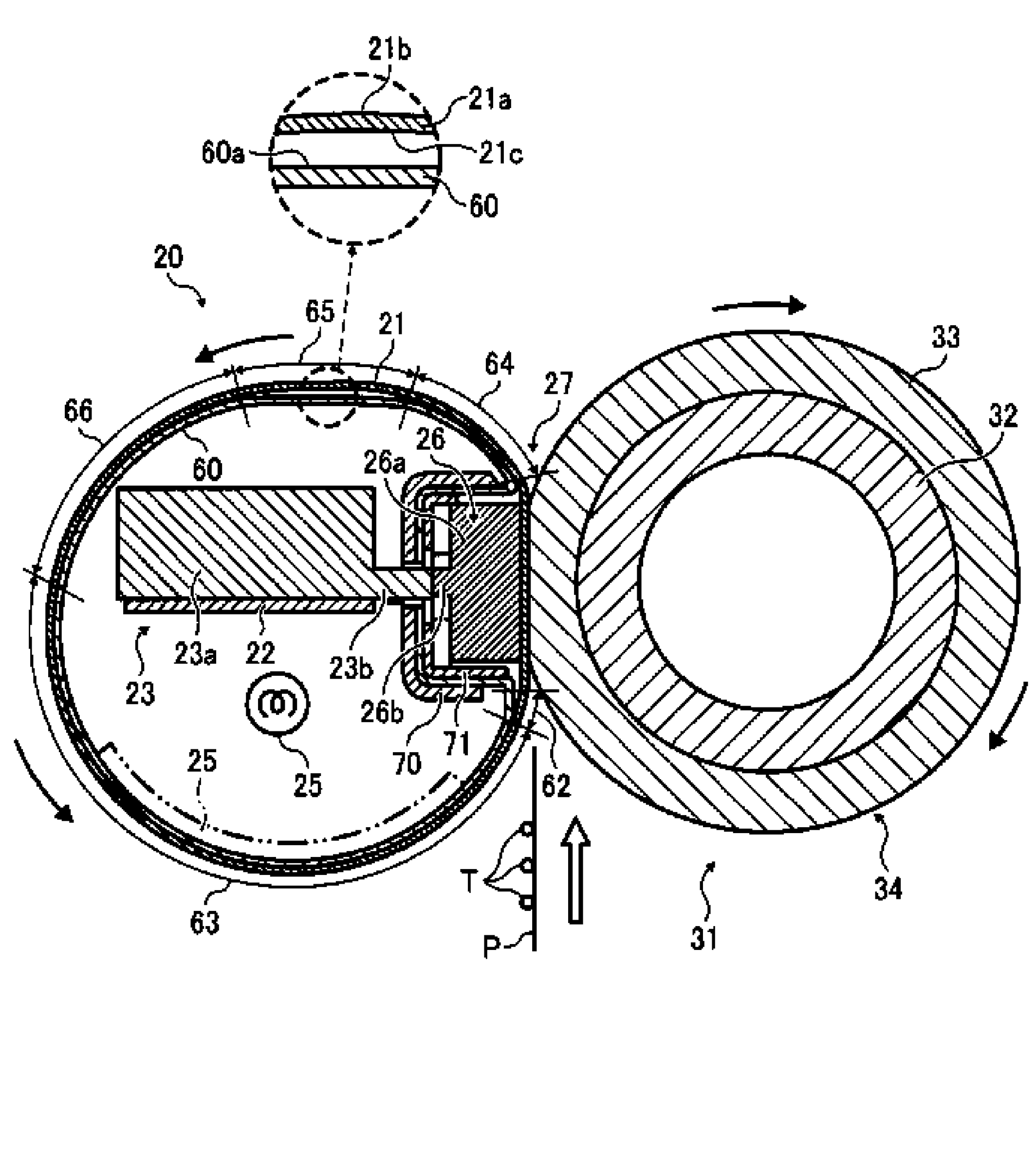
Machine translation of JP 2010026415 A.*

Primary Examiner — Walter L Lindsay, Jr.
Assistant Examiner — Barnabas Fekete
(74) *Attorney, Agent, or Firm* — Oblon, Spivak, McClelland, Maier & Neustadt, L.L.P.

(57) **ABSTRACT**

A fixing device, including a fixing member; a pressure member; a nip forming member; a reinforcing member; a heating member; and a flange member including a cylinder inserted in an inner circumference at an edge of the fixing member in an axial direction thereof and a flange fixed on a frame of the fixing device, wherein the cylinder of the flange member includes a notch storing the nip forming member at a part on the circumference, has an arc-shaped outer circumferential cross-section at an area corresponding to an area where the fixing member is heated by the heating member, having a predetermined radius equivalent to a radius of the fixing member, and the arc has a center located at an upstream side in a recording medium feeding direction relative to a center line of the nip forming member in the recording medium feeding direction.

6 Claims, 13 Drawing Sheets



(56) **References Cited**

U.S. PATENT DOCUMENTS

6,785,505	B2	8/2004	Yasui et al.
6,813,464	B2	11/2004	Amita et al.
6,881,927	B2	4/2005	Yoshinaga et al.
6,882,820	B2	4/2005	Shinshi et al.
6,892,044	B2	5/2005	Yasui et al.
6,937,827	B2	8/2005	Katoh et al.
7,022,944	B2	4/2006	Yoshinaga et al.
7,054,570	B2	5/2006	Kishi et al.
7,116,923	B2	10/2006	Kishi et al.
7,127,204	B2	10/2006	Satoh et al.
7,130,555	B2	10/2006	Kishi et al.
7,151,907	B2	12/2006	Yoshinaga
7,209,675	B2	4/2007	Matsusaka et al.
7,212,758	B2	5/2007	Kishi et al.
7,212,759	B2	5/2007	Kishi et a
7,239,821	B2	7/2007	Matsusaka et al.
7,239,838	B2	7/2007	Sato et al.
7,242,897	B2	7/2007	Satoh et al.
7,308,216	B2	12/2007	Kishi et al.
7,313,353	B2	12/2007	Satoh et al.
7,333,743	B2	2/2008	Kishi et al.
7,343,113	B2	3/2008	Matsusaka et al.
7,352,987	B2	4/2008	Iwata et al.
7,356,270	B2	4/2008	Matsusaka et al.
7,366,432	B2	4/2008	Kishi et al.
7,373,094	B2	5/2008	Kishi et al.
7,379,698	B2	5/2008	Yoshinaga
7,437,111	B2	10/2008	Yamada et al.
7,454,151	B2	11/2008	Satoh et al.
7,466,949	B2	12/2008	Satoh et al.
7,486,916	B2	2/2009	Tsuda et al.
7,496,309	B2	2/2009	Matsusaka et al.
7,509,085	B2	3/2009	Yoshinaga et al.
7,515,845	B2	4/2009	Kishi et al.
7,546,049	B2	6/2009	Ehara et al.
7,551,869	B2	6/2009	Kishi et al.
7,565,087	B2	7/2009	Matsusaka et al.
7,570,910	B2	8/2009	Ishii
7,603,049	B2	10/2009	Kishi et al.
7,609,988	B2	10/2009	Kishi et al.
7,664,410	B2	2/2010	Takagi
7,702,271	B2	4/2010	Yamada et al.
7,783,240	B2	8/2010	Ito et al.
7,796,933	B2	9/2010	Ueno et al.
7,801,457	B2	9/2010	Seo et al.
7,824,834	B2	11/2010	Awamura et al.
7,840,151	B2	11/2010	Fujimoto
7,885,569	B2	2/2011	Kishi et al.
7,912,392	B2	3/2011	Yoshinaga et al.
7,925,177	B2	4/2011	Ishii et al.
7,953,338	B2	5/2011	Takagi
7,957,663	B2	6/2011	Kishi et al.
7,983,598	B2	7/2011	Shinshi et al.
8,023,861	B2	9/2011	Yoshinaga et al.
2005/0123315	A1	6/2005	Kishi et al.
2006/0051111	A1	3/2006	Kishi et al.
2006/0257183	A1	11/2006	Ehara et al.
2007/0014600	A1	1/2007	Ishii et al.
2007/0031159	A1	2/2007	Kishi et al.
2008/0063443	A1	3/2008	Yoshinaga et al.
2008/0317532	A1	12/2008	Ehara et al.
2009/0067902	A1	3/2009	Yoshinaga et al.
2009/0123201	A1	5/2009	Ehara et al.
2009/0123202	A1	5/2009	Yoshinaga et al.
2009/0169232	A1	7/2009	Kunii et al.
2010/0074667	A1	3/2010	Ehara et al.
2010/0092220	A1	4/2010	Hasegawa et al.
2010/0092221	A1	4/2010	Shinshi et al.
2010/0202809	A1	8/2010	Shinshi et al.
2010/0290822	A1	11/2010	Hasegawa et al.
2010/0303521	A1	12/2010	Ogawa et al.
2011/0026988	A1	2/2011	Yoshikawa et al.
2011/0044706	A1	2/2011	Iwaya et al.
2011/0044734	A1	2/2011	Shimokawa et al.
2011/0052237	A1	3/2011	Yoshikawa et al.
2011/0052245	A1	3/2011	Shinshi et al.
2011/0052277	A1	3/2011	Ueno et al.
2011/0052282	A1	3/2011	Shinshi et al.
2011/0058862	A1	3/2011	Yamaguchi et al.
2011/0058863	A1	3/2011	Shinshi et al.
2011/0058864	A1	3/2011	Fujimoto et al.
2011/0058865	A1	3/2011	Tokuda et al.
2011/0058866	A1	3/2011	Ishii et al.
2011/0064437	A1	3/2011	Yamashina et al.
2011/0064443	A1	3/2011	Iwaya et al.
2011/0064450	A1	3/2011	Ishii et al.
2011/0064451	A1	3/2011	Yamaguchi et al.
2011/0064490	A1	3/2011	Imada et al.
2011/0064502	A1	3/2011	Hase et al.
2011/0076071	A1	3/2011	Yamaguchi et al.
2011/0085832	A1	4/2011	Hasegawa et al.
2011/0116848	A1	5/2011	Yamaguchi et al.
2011/0129268	A1	6/2011	Ishii et al.
2011/0150518	A1	6/2011	Hase et al.
2011/0170917	A1	7/2011	Yoshikawa et al.
2011/0176822	A1	7/2011	Ishii et al.
2011/0182634	A1	7/2011	Ishigaya et al.
2011/0182638	A1	7/2011	Ishii et al.
2011/0194869	A1	8/2011	Yoshinaga et al.
2011/0194870	A1	8/2011	Hase et al.
2011/0200368	A1	8/2011	Yamaguchi et al.
2011/0200370	A1	8/2011	Ikebuchi et al.
2011/0206427	A1	8/2011	Iwaya et al.
2011/0211876	A1	9/2011	Iwaya et al.
2011/0217056	A1	9/2011	Yoshinaga et al.
2011/0217057	A1	9/2011	Yoshinaga et al.
2011/0217093	A1	9/2011	Tokuda et al.
2011/0217095	A1	9/2011	Ishii et al.
2011/0222875	A1	9/2011	Imada et al.
2011/0222888	A1	9/2011	Ikebuchi et al.
2011/0222926	A1	9/2011	Ueno et al.
2011/0222929	A1	9/2011	Fujimoto et al.
2011/0222930	A1	9/2011	Fujimoto et al.
2011/0222931	A1	9/2011	Shinshi et al.
2011/0229178	A1	9/2011	Ogawa et al.
2011/0229181	A1	9/2011	Iwaya et al.
2011/0229200	A1	9/2011	Yamaguchi et al.
2011/0229225	A1	9/2011	Ishii et al.
2011/0229226	A1	9/2011	Tokuda et al.
2011/0229227	A1	9/2011	Yoshikawa et al.
2011/0229228	A1	9/2011	Yoshikawa et al.
2011/0274453	A1	11/2011	Shimokawa et al.
2011/0286758	A1	11/2011	Yoshinaga

FOREIGN PATENT DOCUMENTS

JP	10-213984		8/1998
JP	11-2982		1/1999
JP	2004-163464		6/2004
JP	2006-39184		2/2006
JP	2006-220950		8/2006
JP	2007-334205		12/2007
JP	2010026415 A	*	2/2010
JP	2010-96782		4/2010

* cited by examiner

FIG. 1

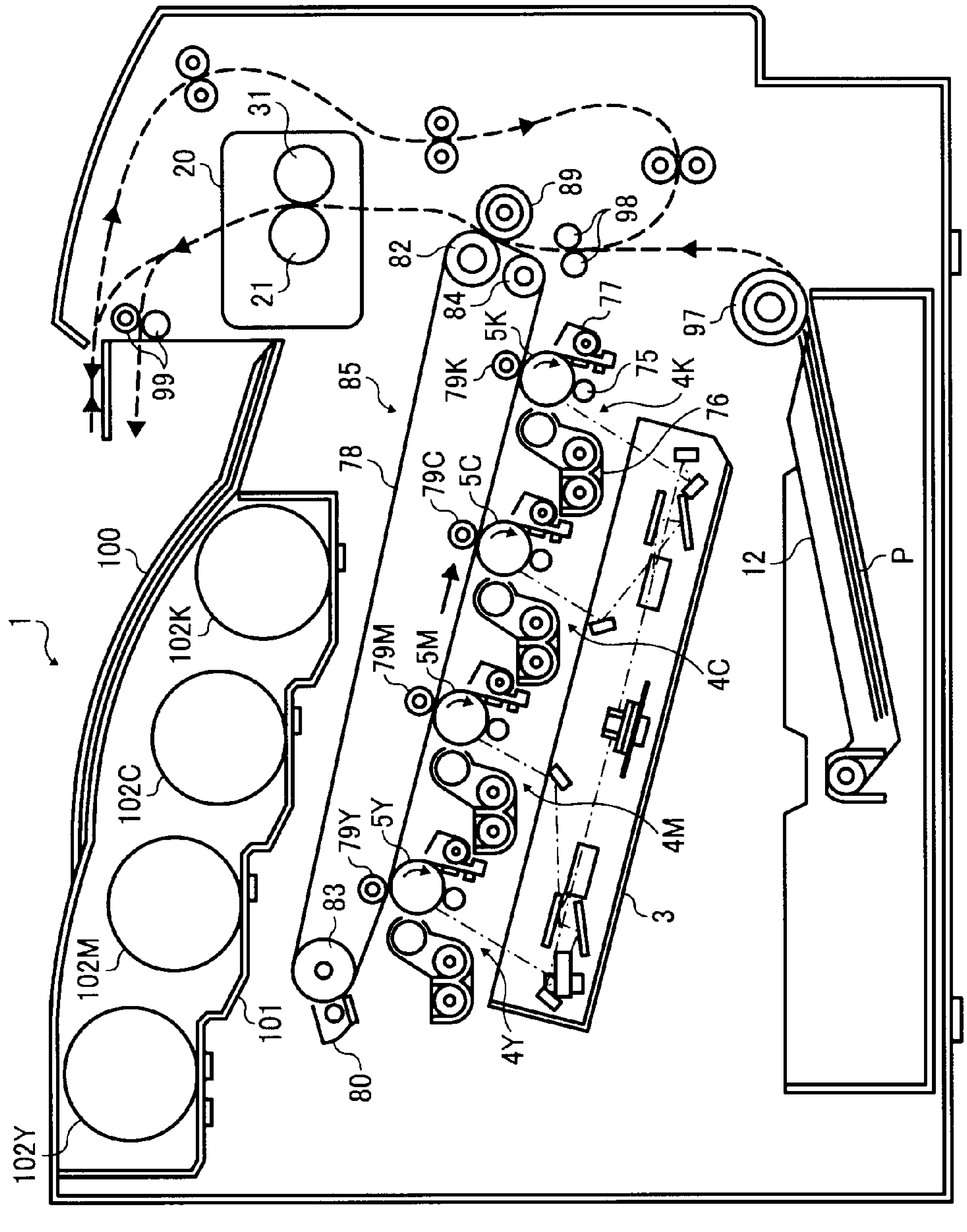

1
100
102K
102C
102M
102Y
101
80
83
79Y
5Y
4Y
79M
5M
4M
79C
5C
4C
78
85
79K
5K
4K
75
76
77
84
82
89
98
97
12
P
3
20
21
31
99

FIG. 2

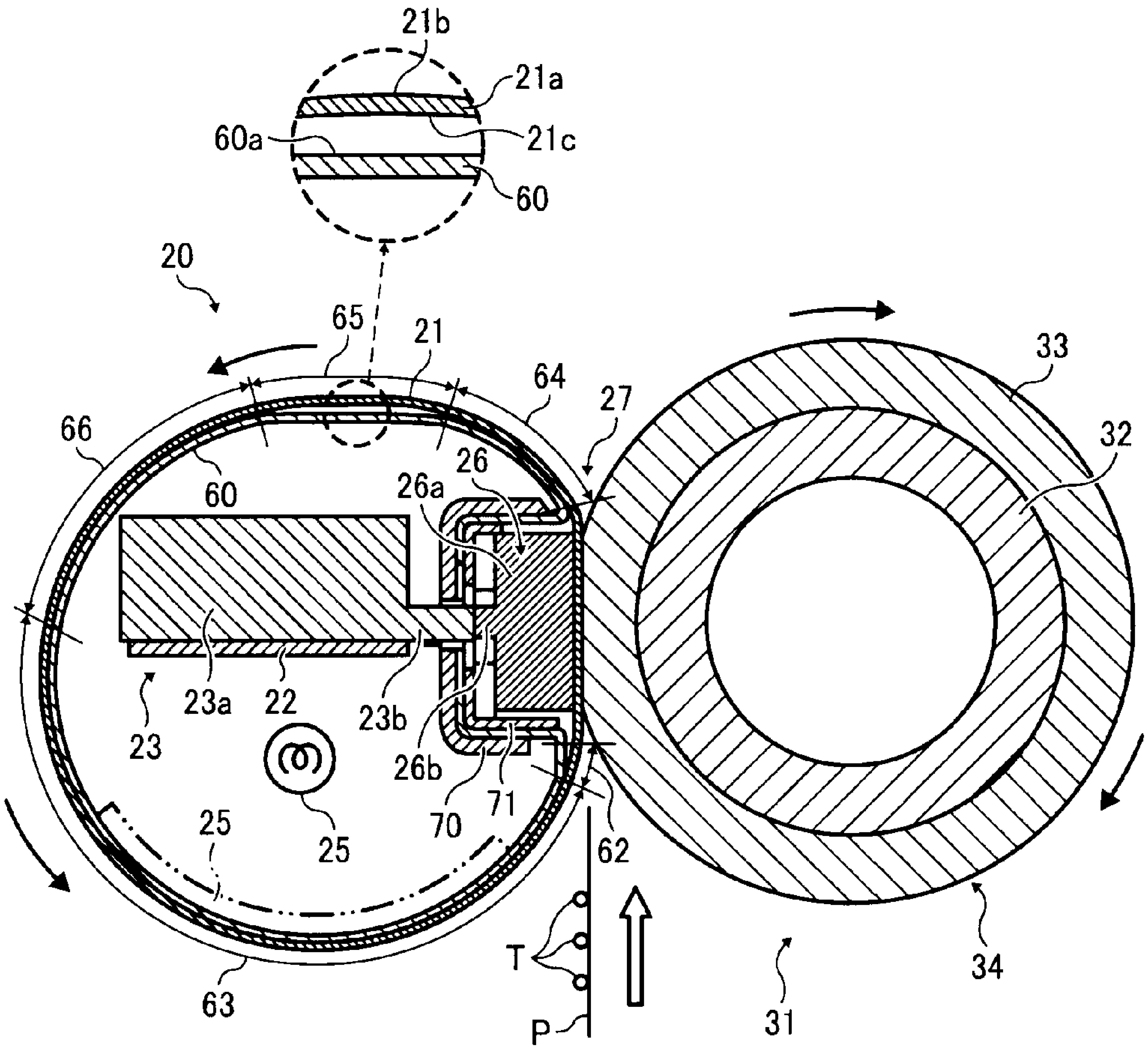

21b
21a
21c
60a
60
20
65
21
64
27
33
32
66
60
26
26a
23a
22
23b
23
26b
25
25
25
70
71
62
T
P
63
31
34

FIG. 3

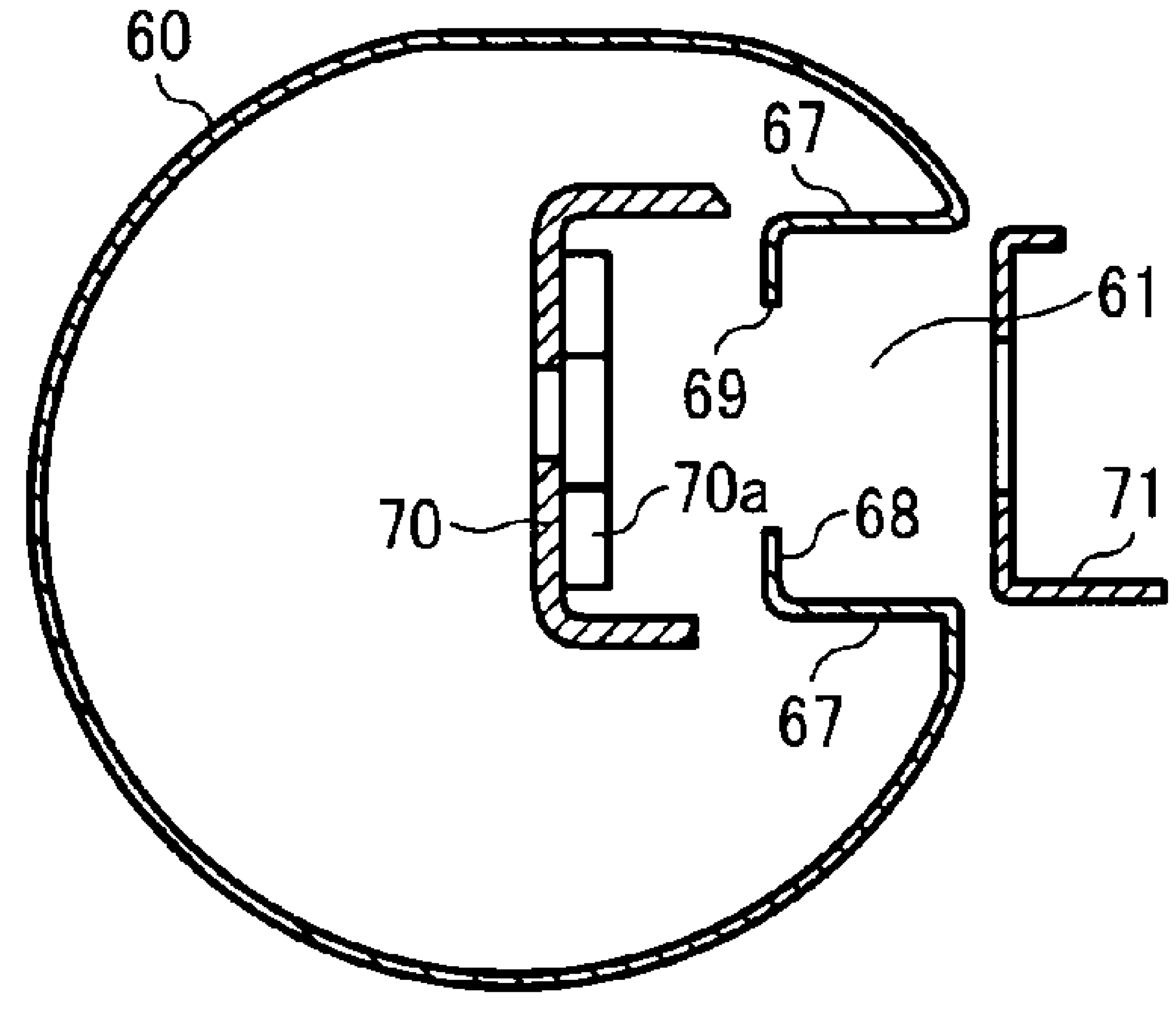

60
67
61
69
70
70a
68
71
67

FIG. 4

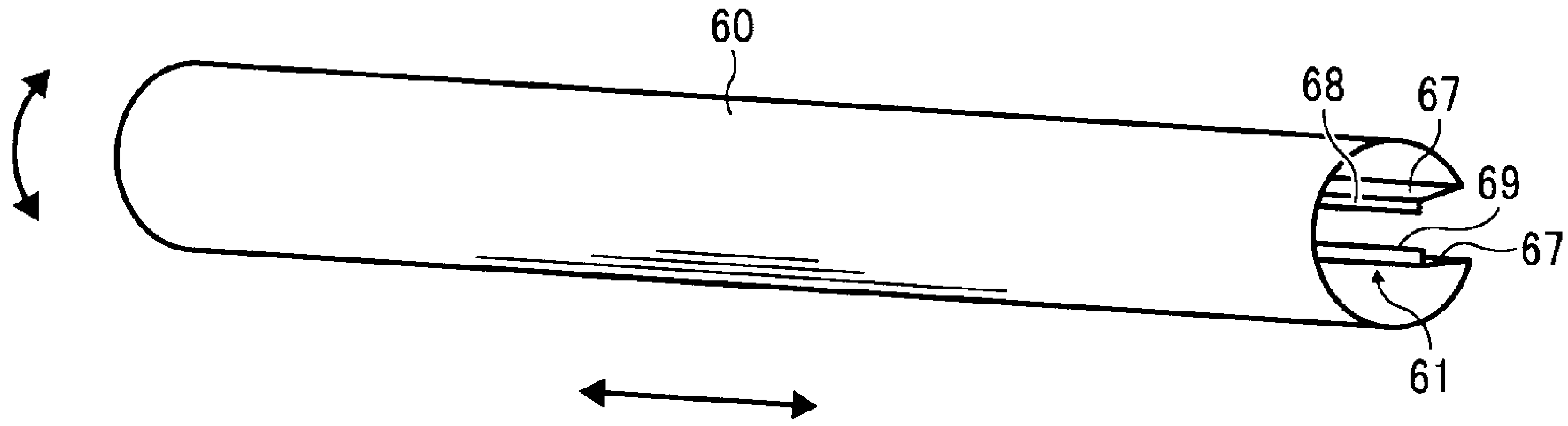

60
68
67
69
67
61

FIG. 5

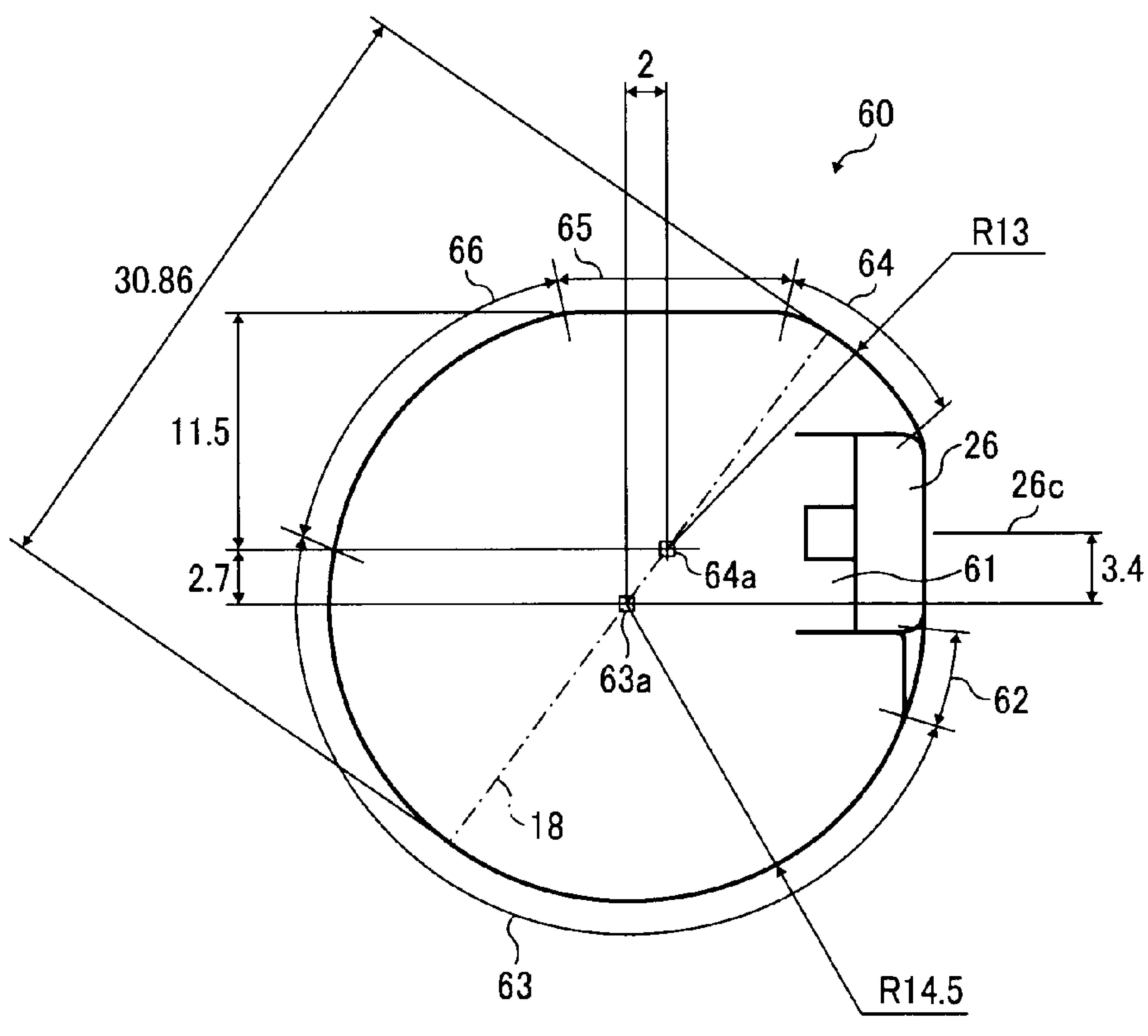

2
60
30.86
66
65
64
R13
11.5
26
26c
2.7
64a
61
3.4
63a
62
18
63
R14.5

FIG. 6

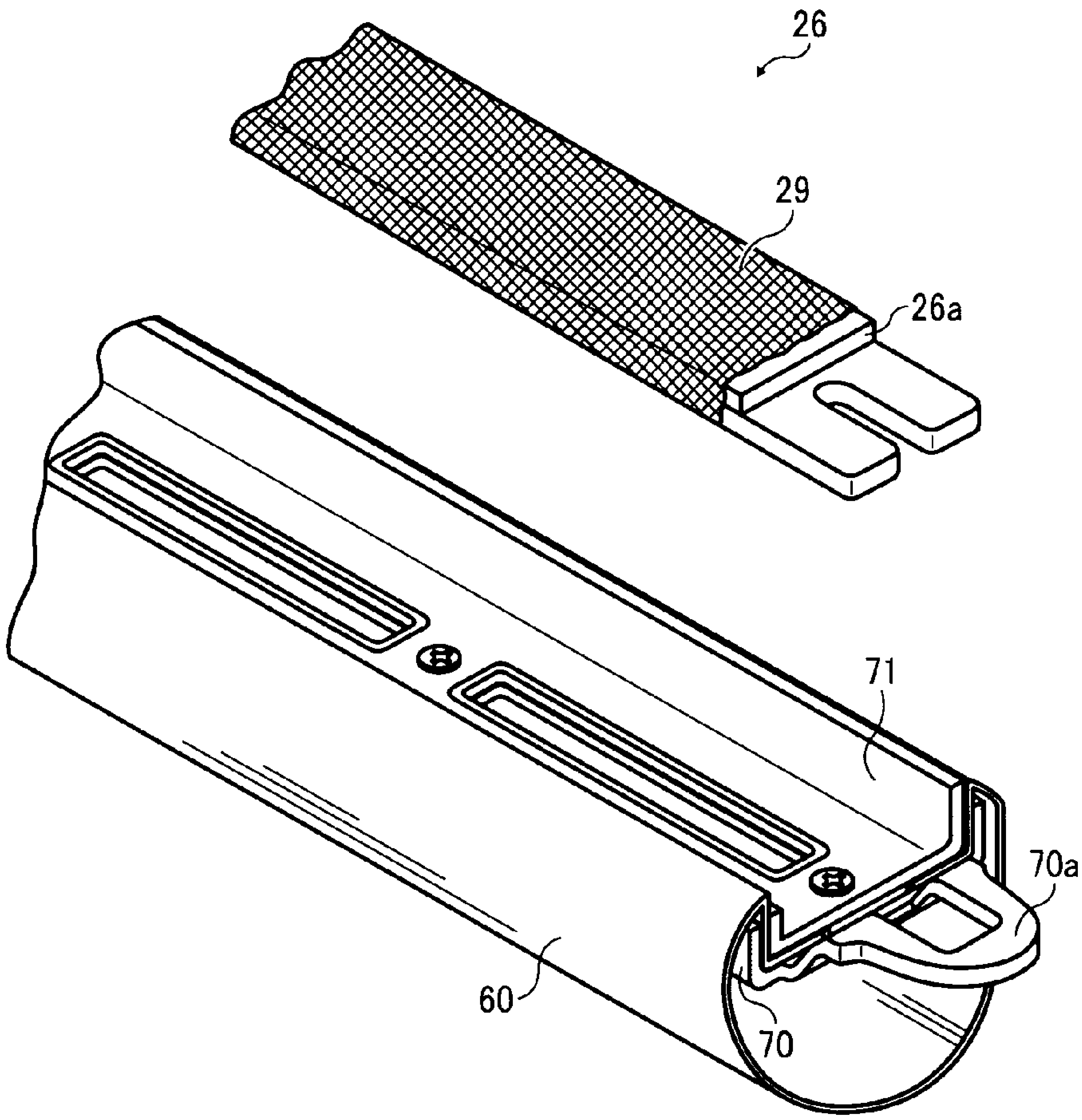


FIG. 7

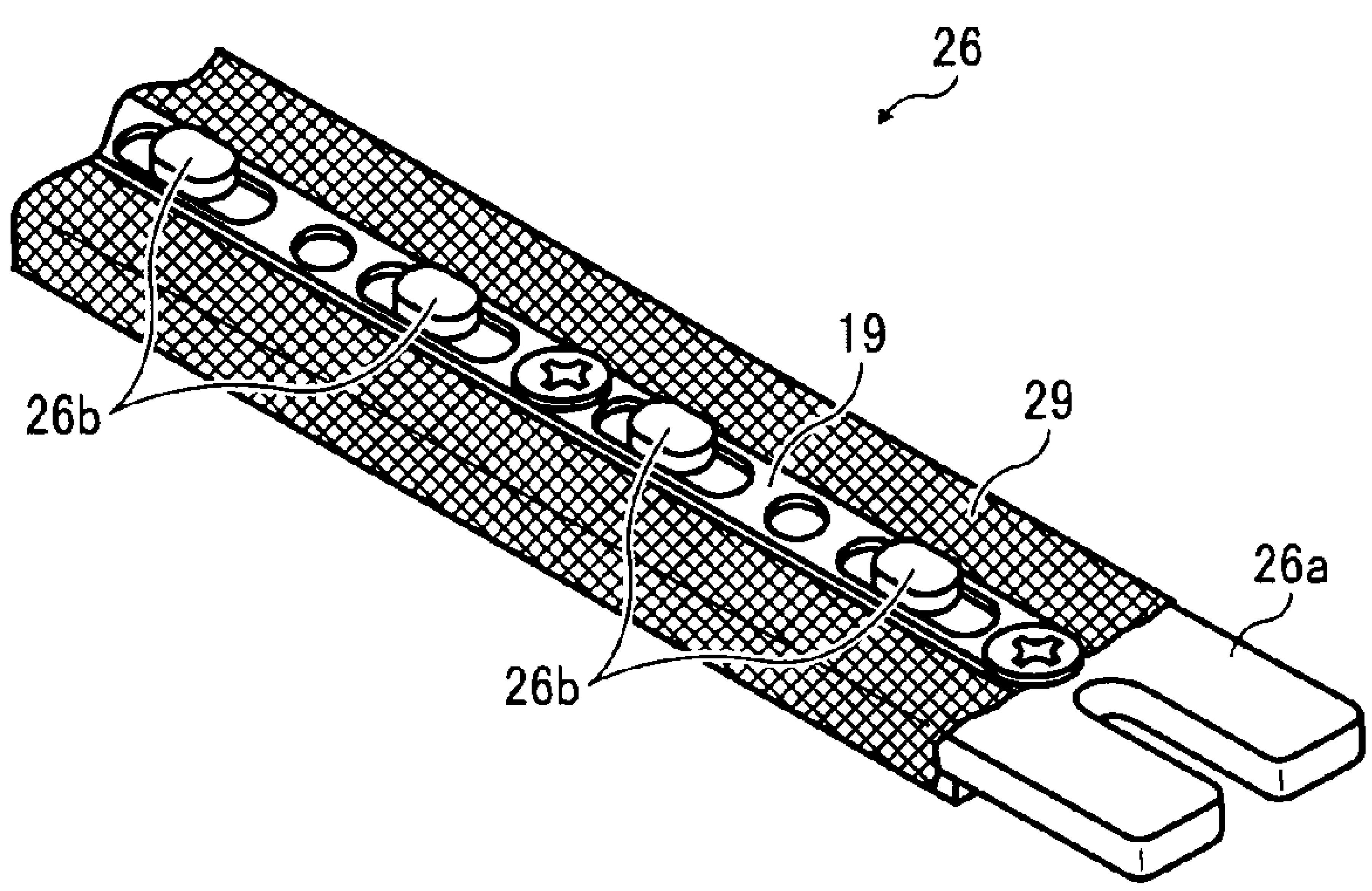


FIG. 8

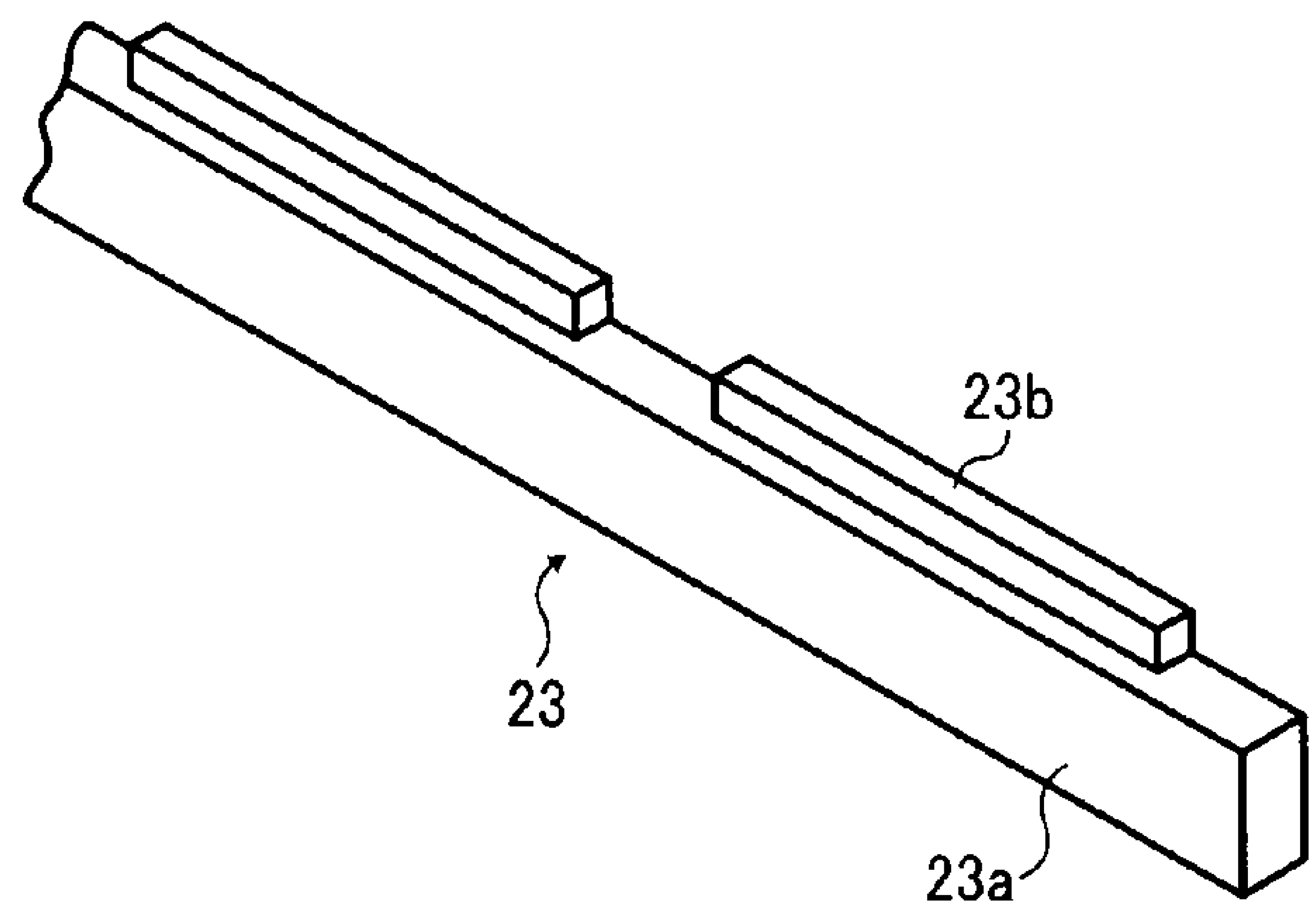


FIG. 9

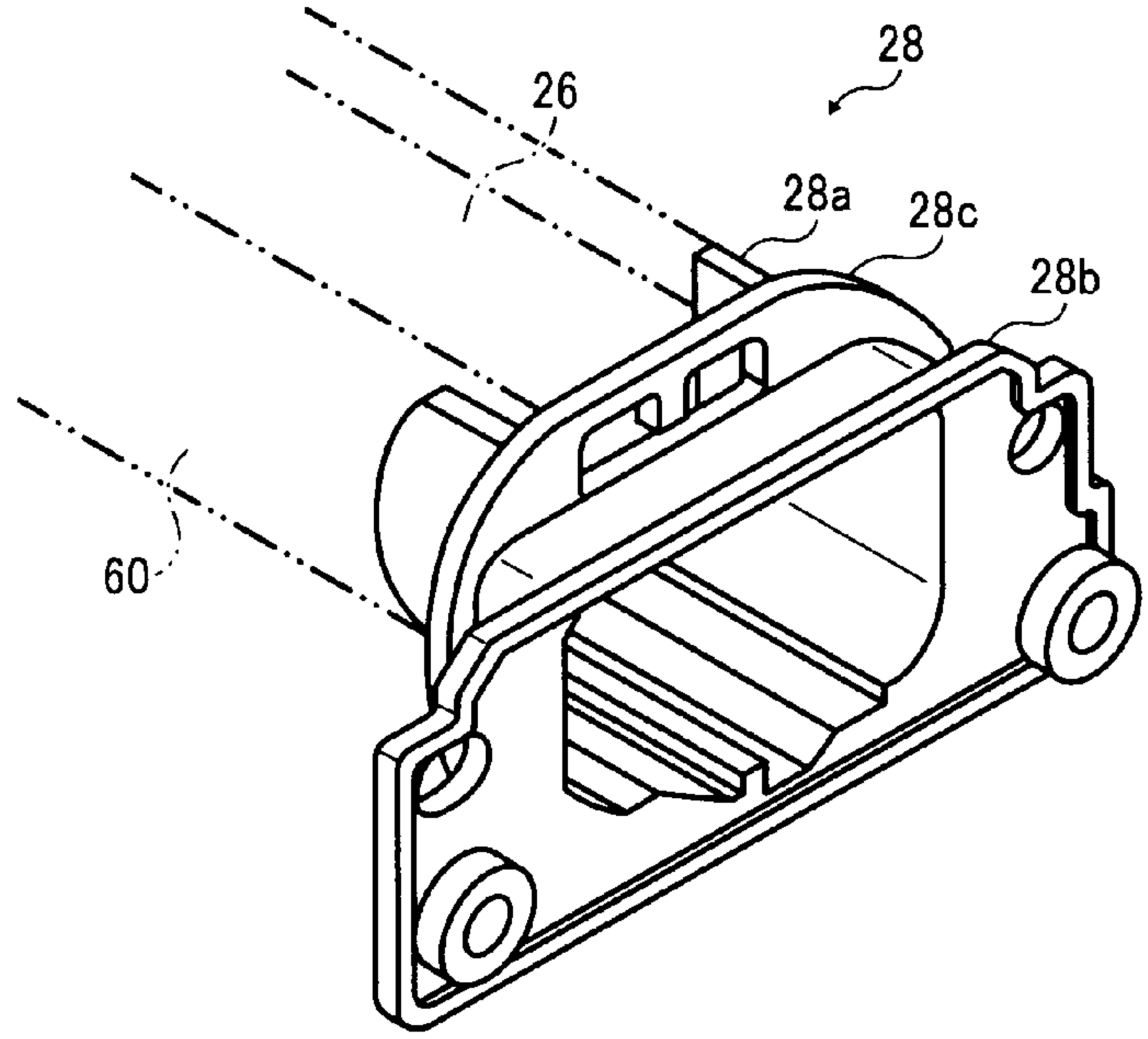


FIG. 10

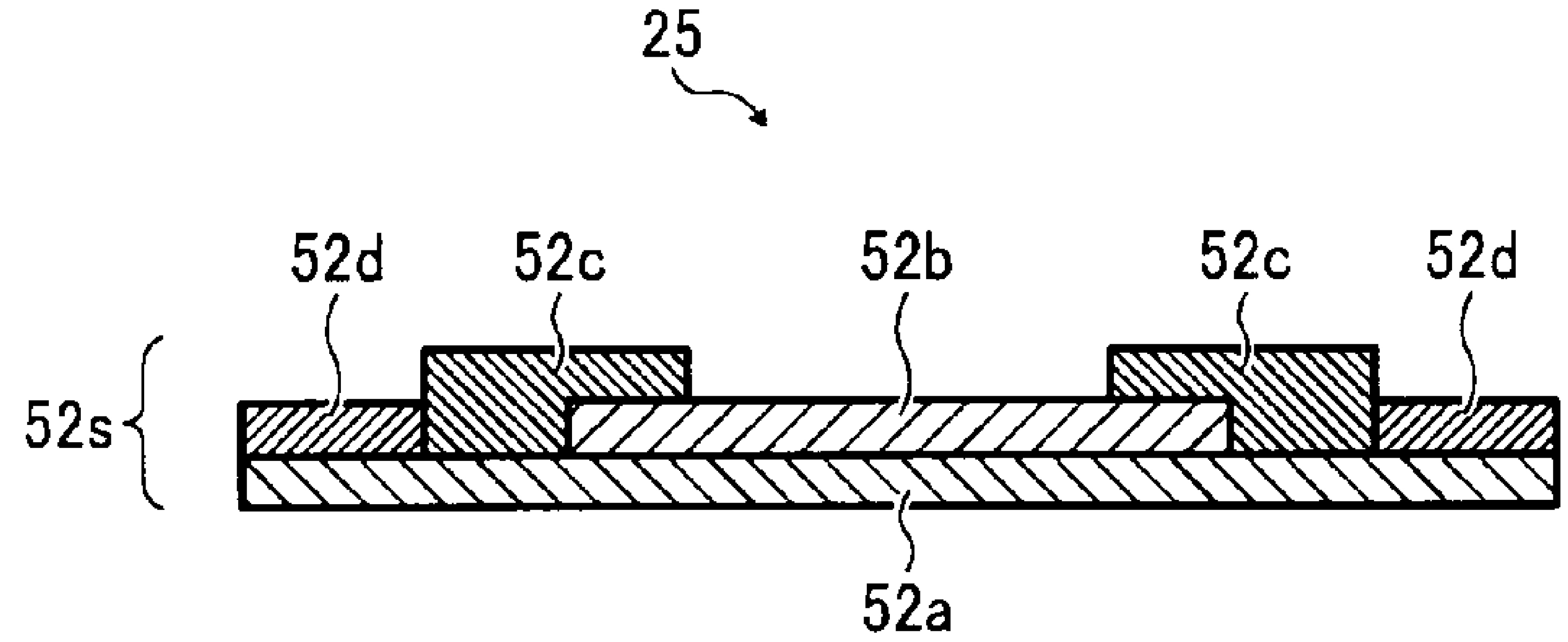


FIG. 11

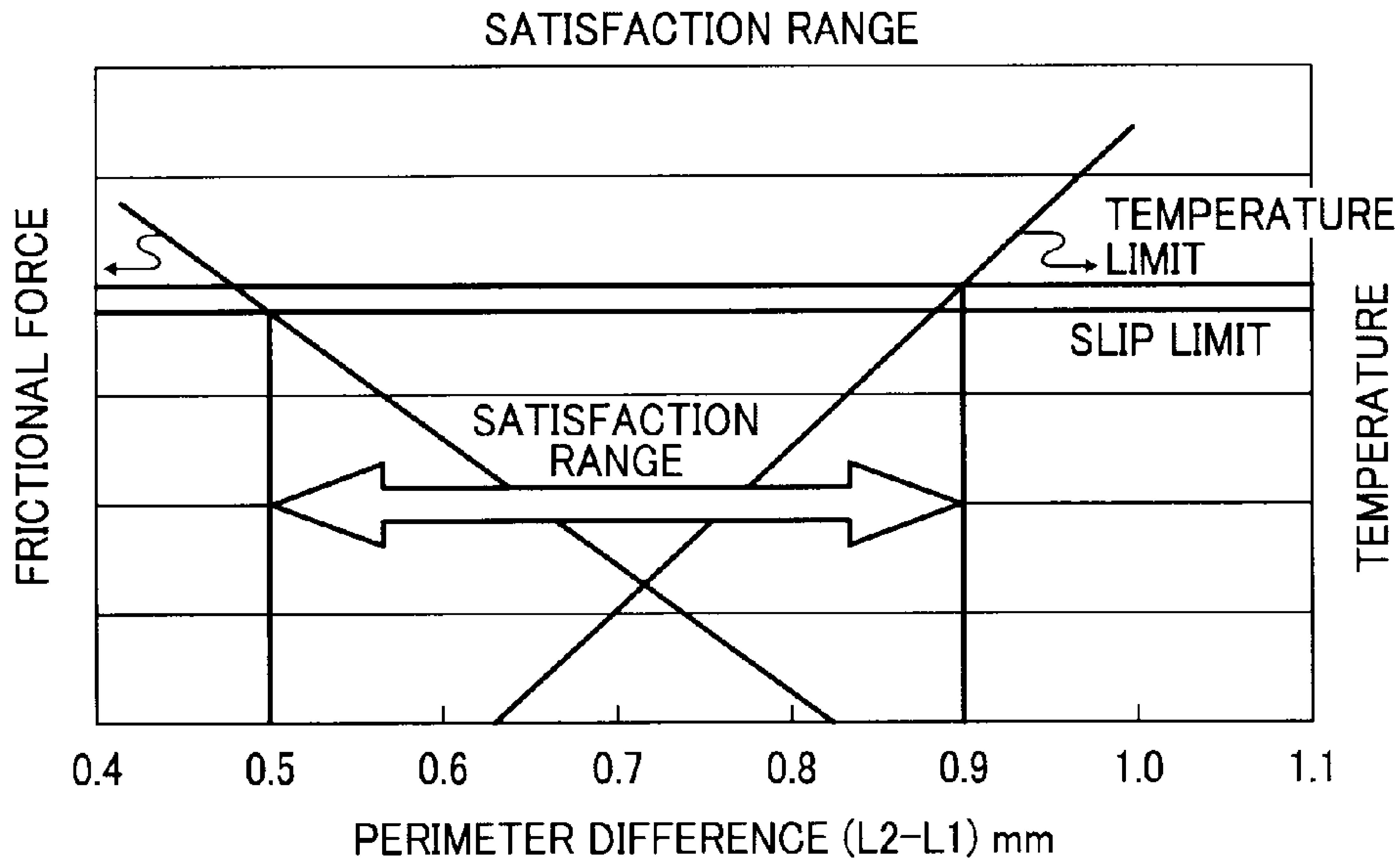

SATISFACTION RANGE
FRICTIONAL FORCE
TEMPERATURE LIMIT
SLIP LIMIT
TEMPERATURE
SATISFACTION RANGE
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
PERIMETER DIFFERENCE (L2−L1) mm

FIG. 12

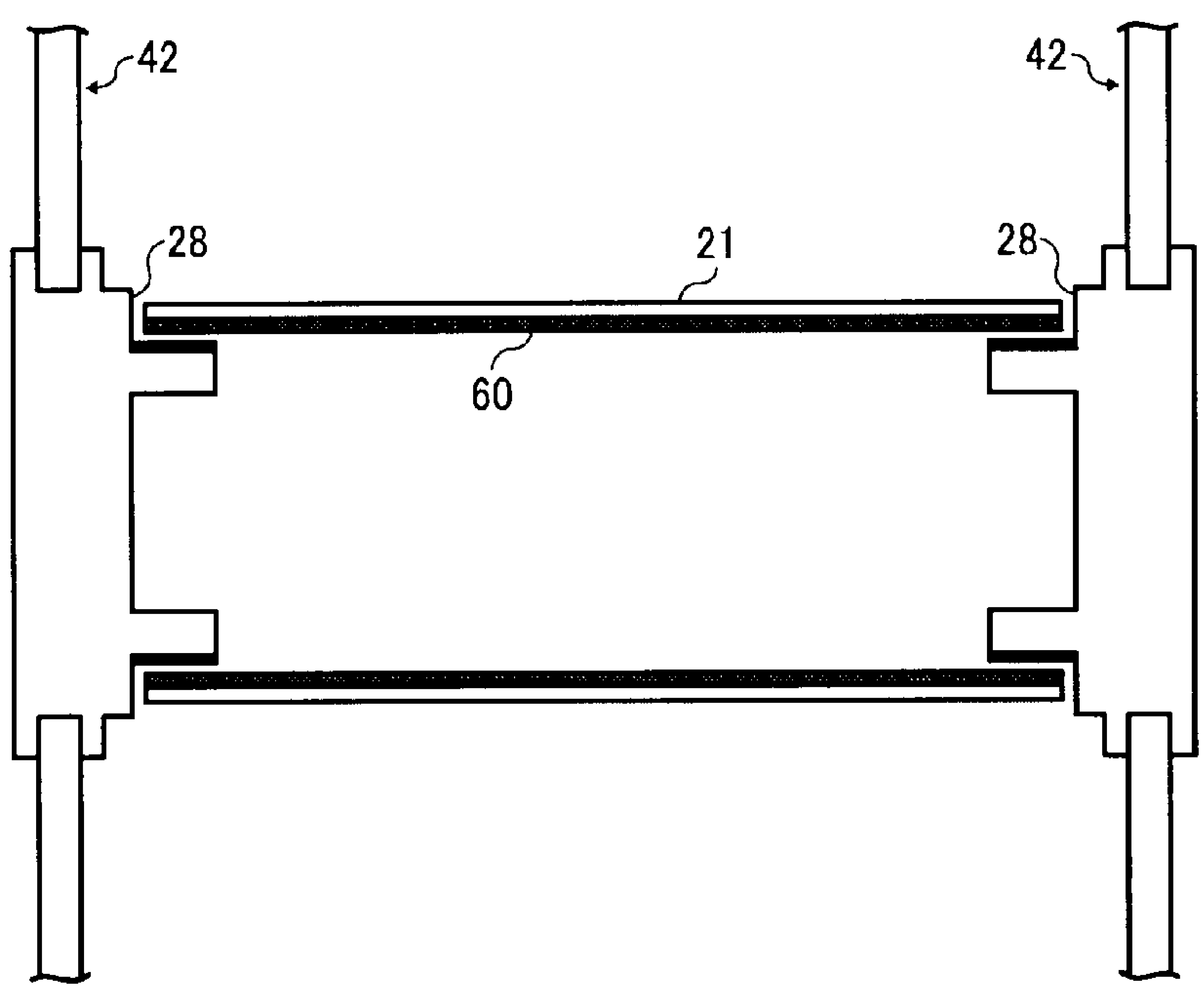

42
42
28
21
28
60

FIG. 13

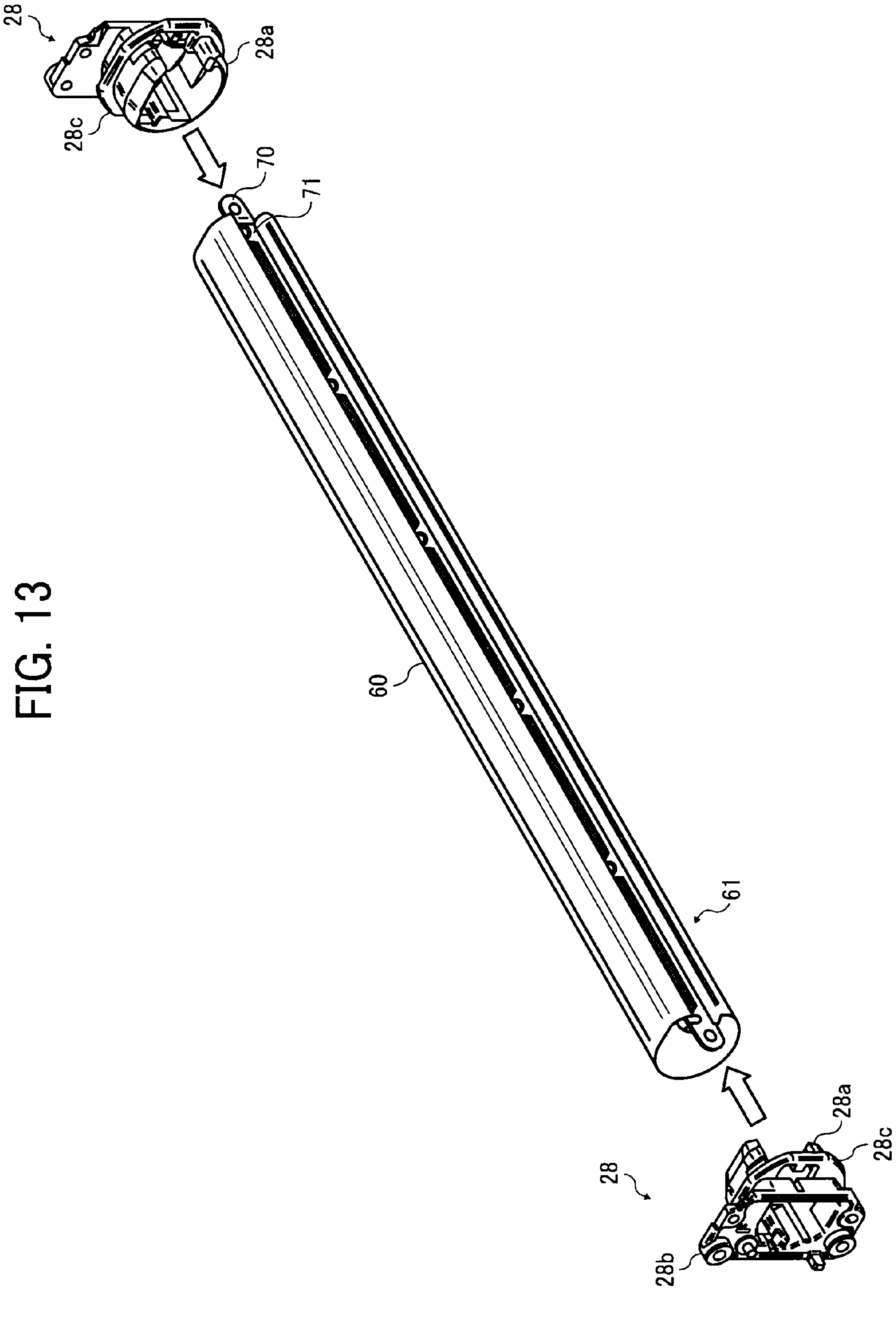
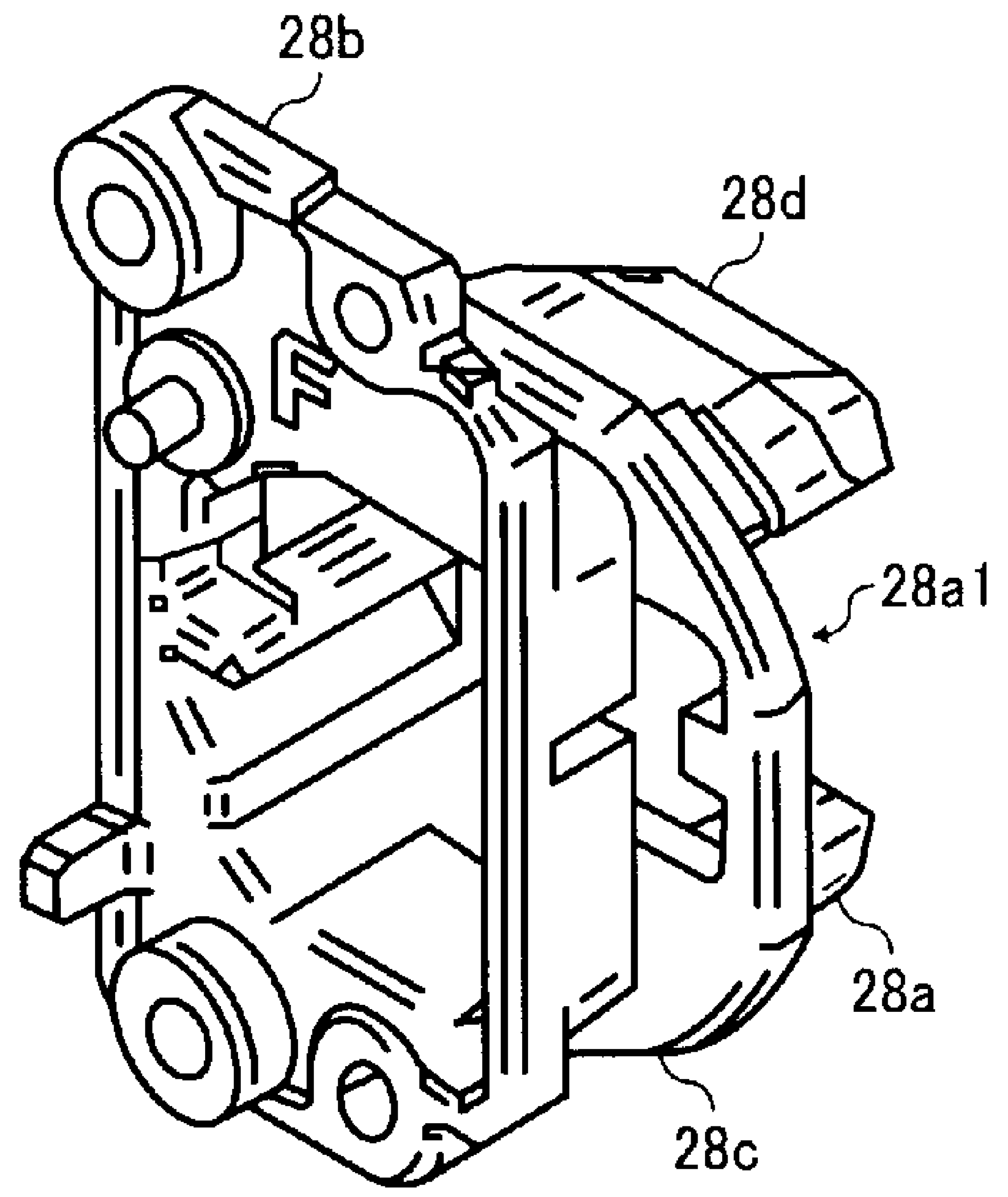
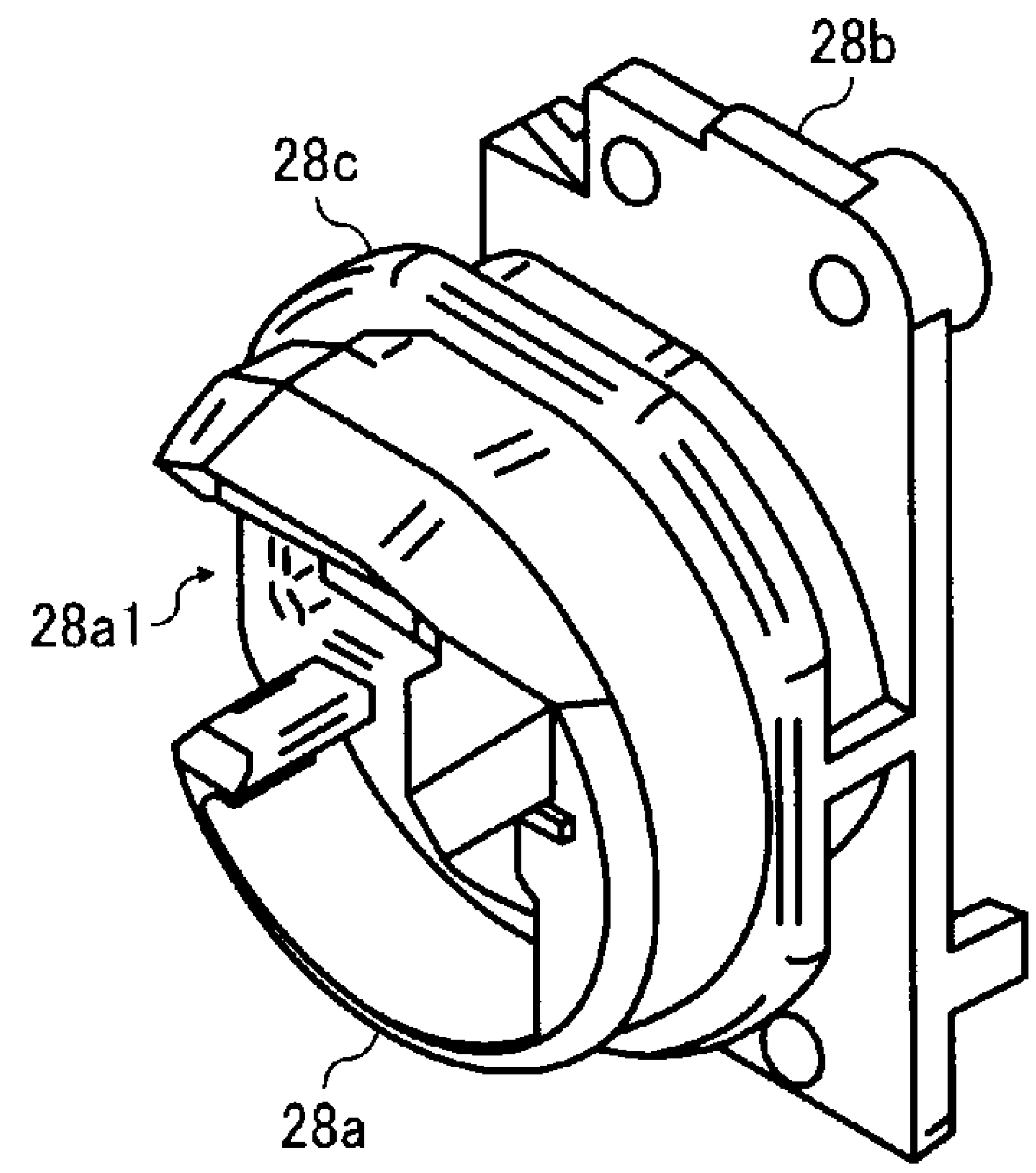


FIG. 14A



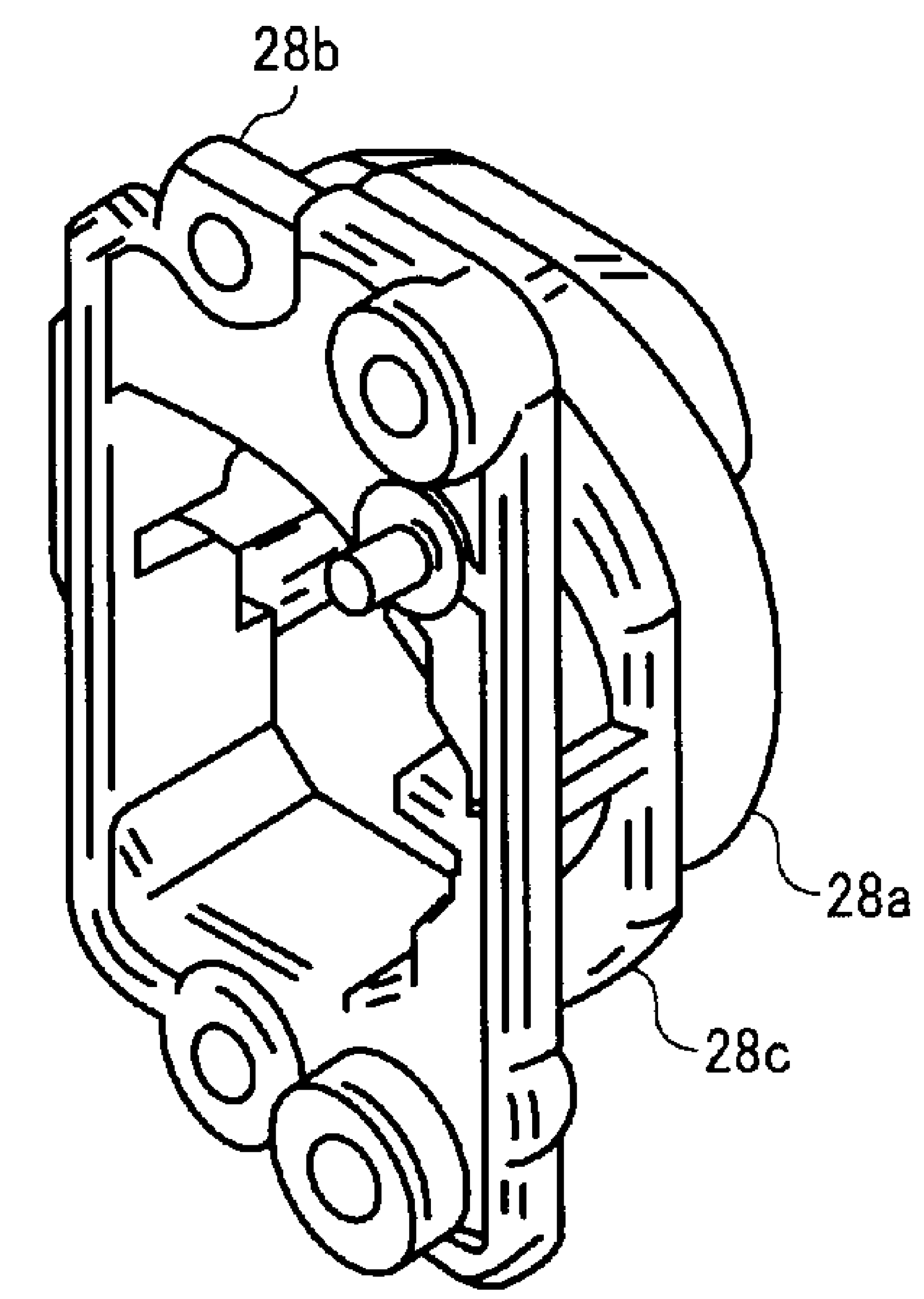
VIEW FROM FRONT SIDE

FIG. 14B



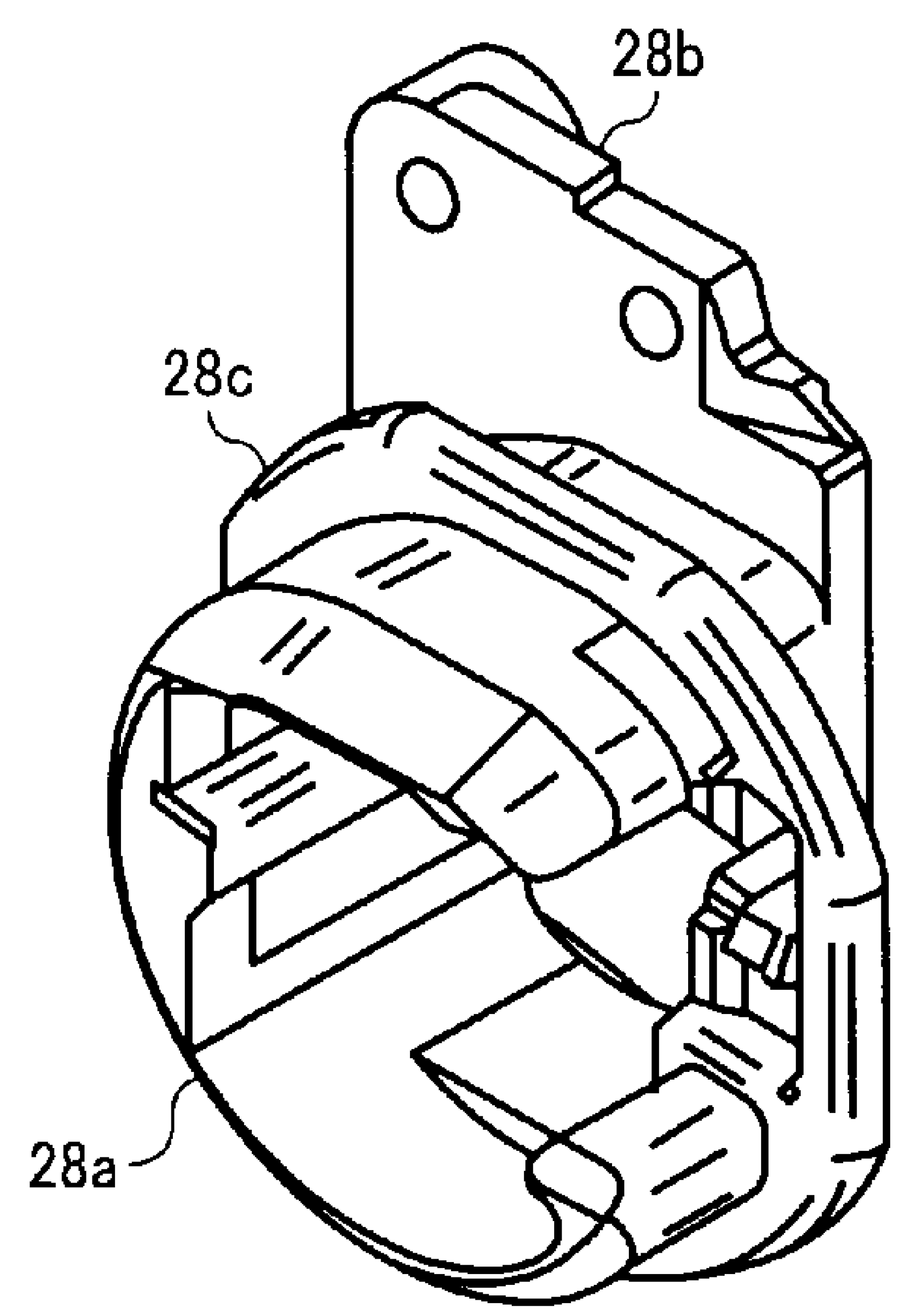
VIEW FROM BACK SIDE

FIG. 14C



VIEW FROM FRONT SIDE

FIG. 14D



VIEW FROM BACK SIDE

FIG. 15

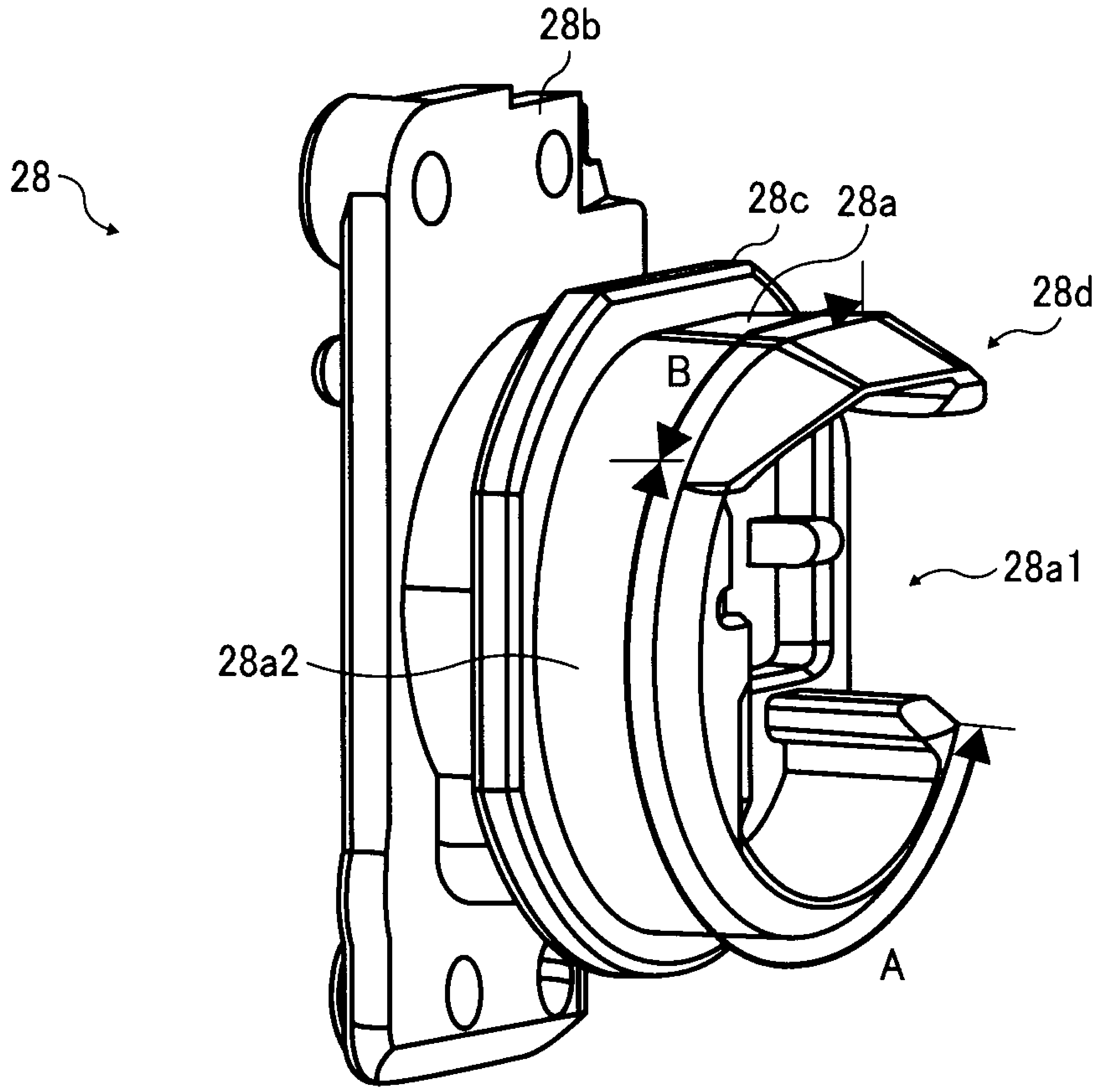
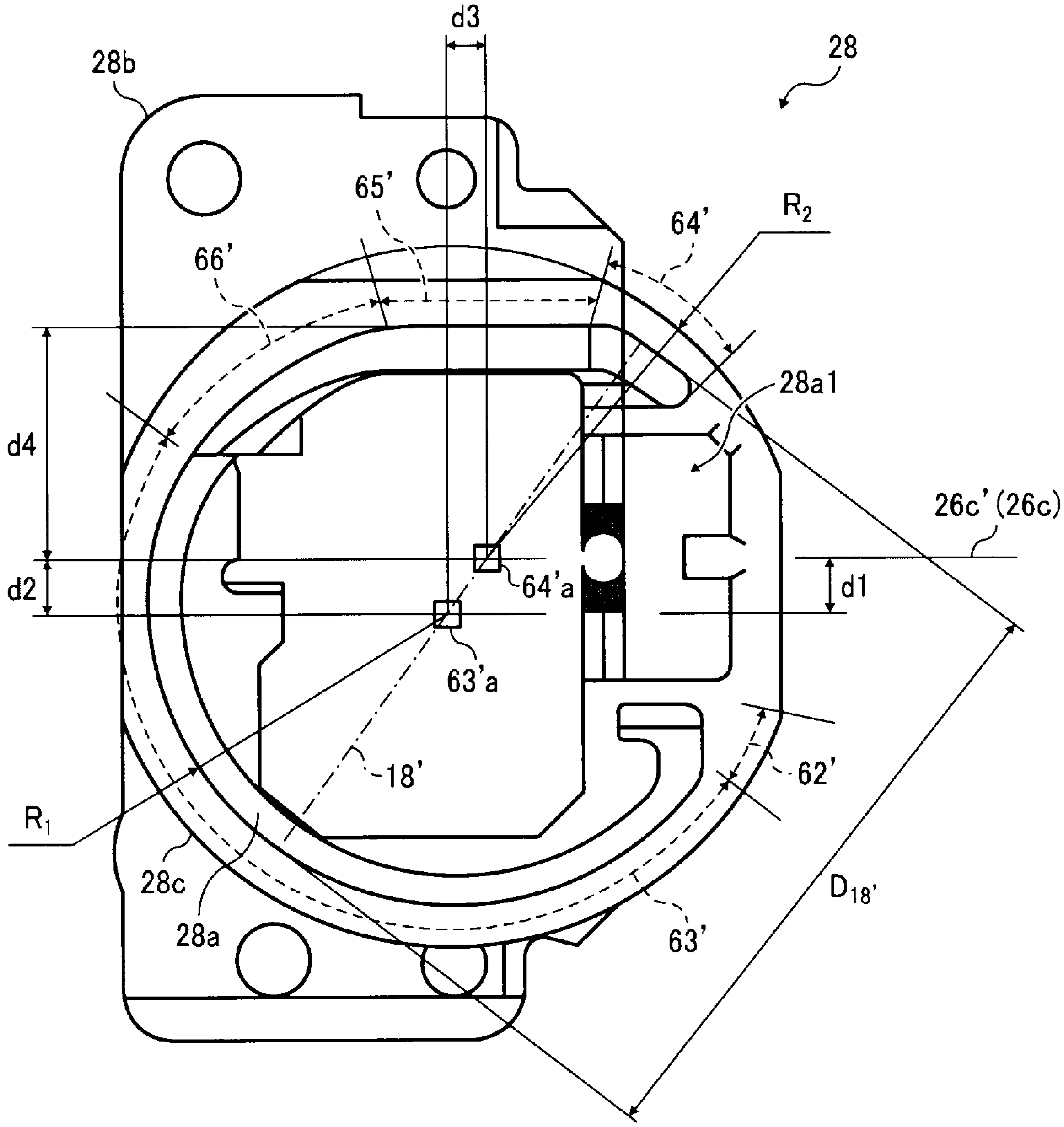


FIG. 16



28b
d3
28
65'
64'
R_2
66'
28a1
d4
26c'(26c)
d2
64'a
d1
63'a
62'
-18'
R_1
$D_{18'}$
28c
63'
28a

FIG. 17

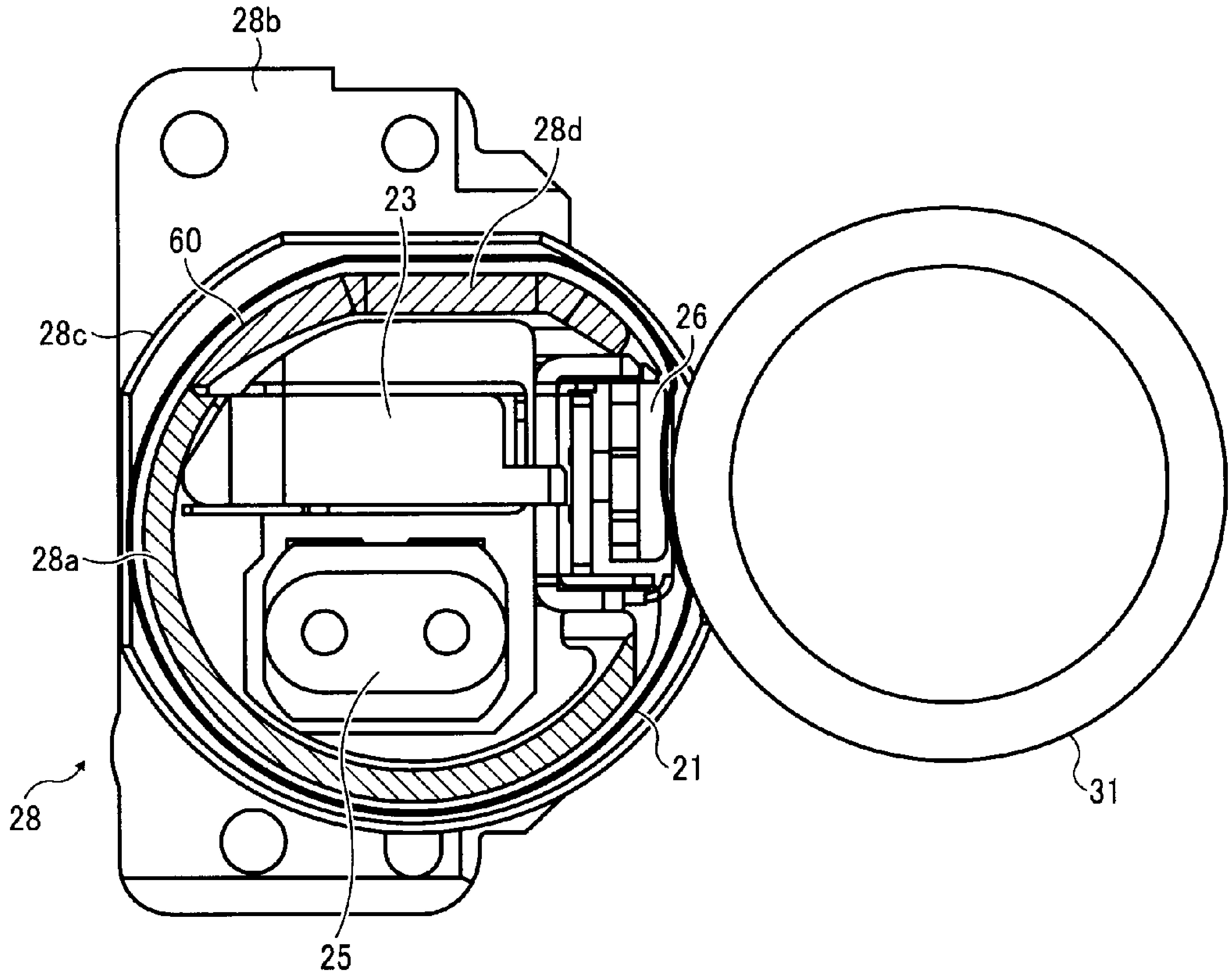


FIG. 18

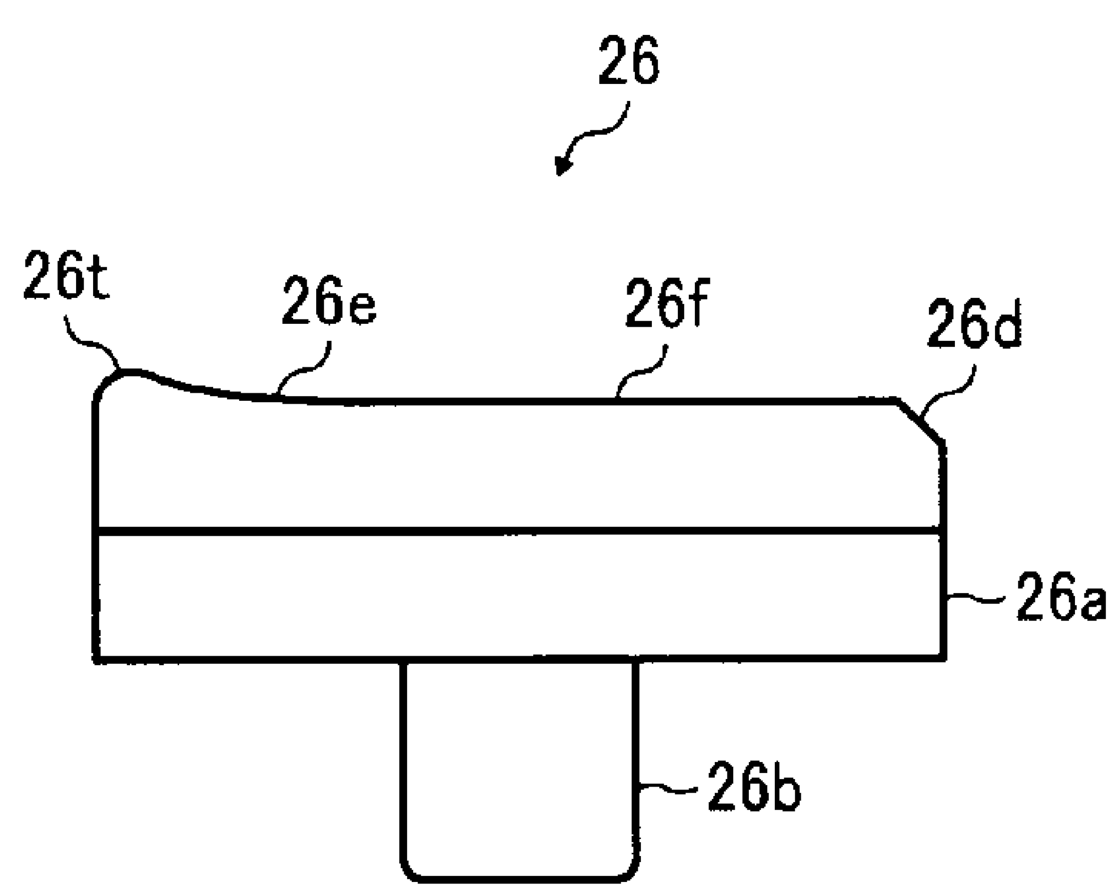


FIG. 19

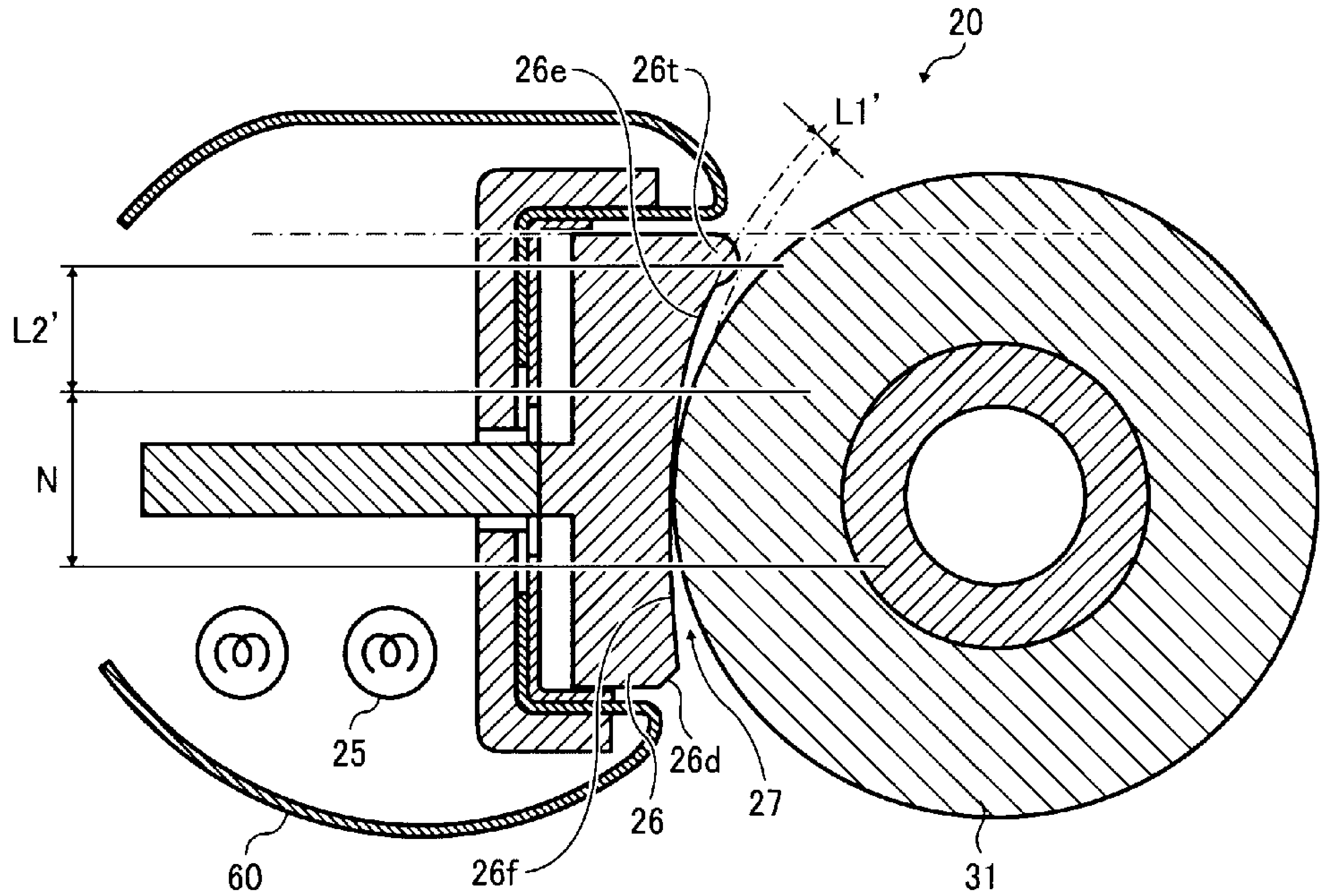

20
26e
26t
L1'
L2'
N
25
60
26f
26
26d
27
31

FIG. 20

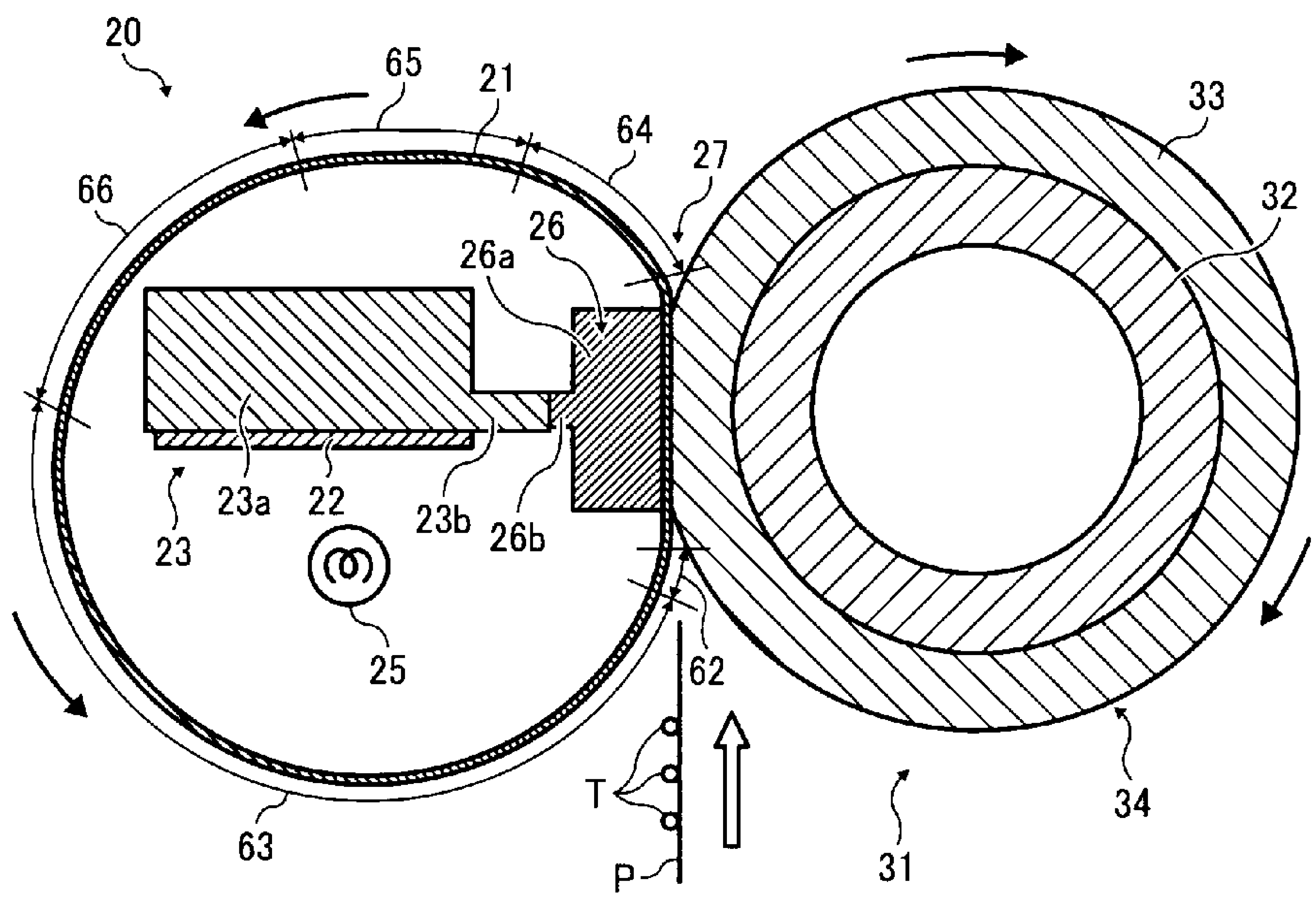

20
65
21
64
27
33
32
66
26
26a
23a
22
23b
26b
23
25
62
T
P
63
31
34

FIG. 21

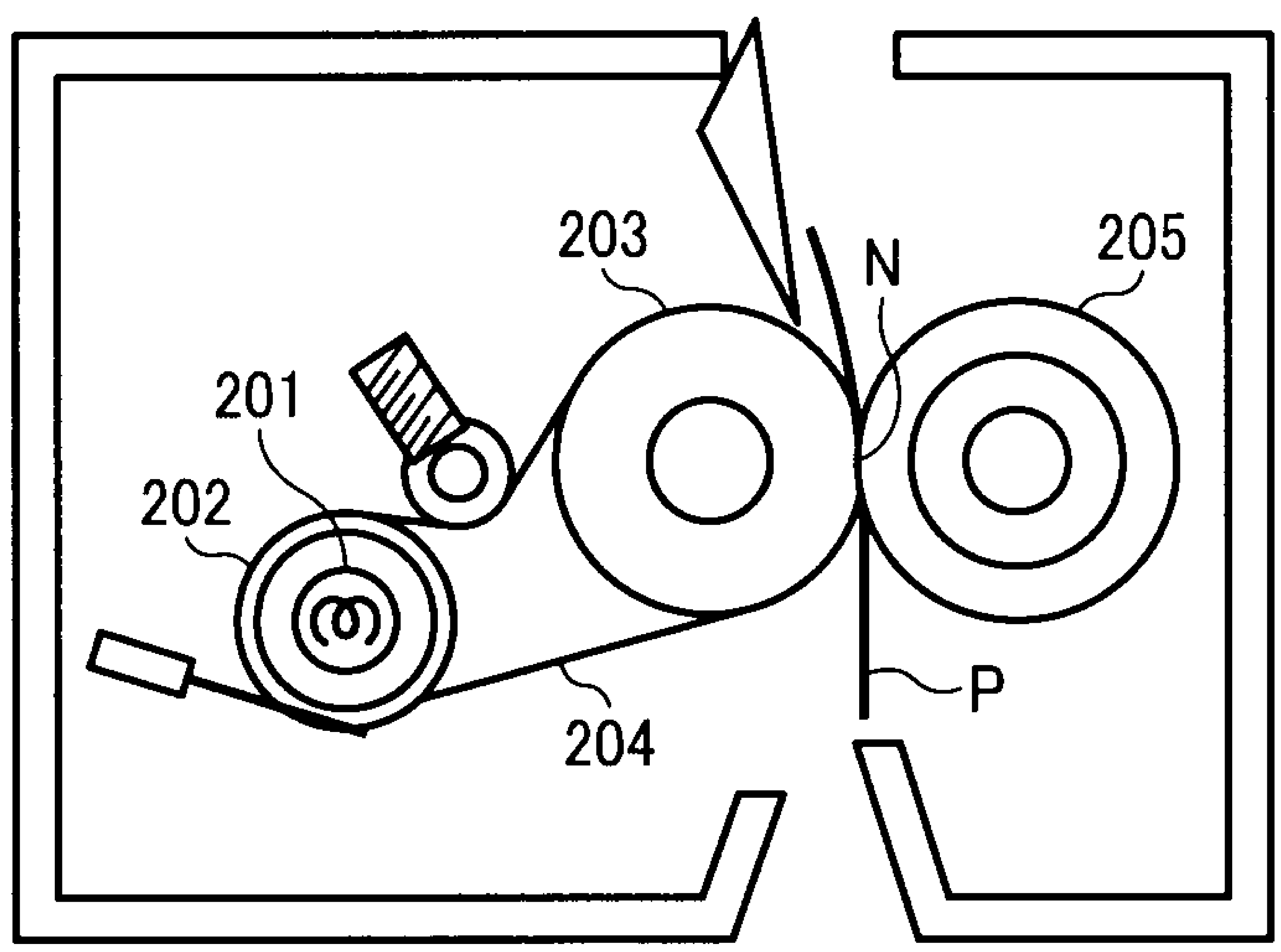
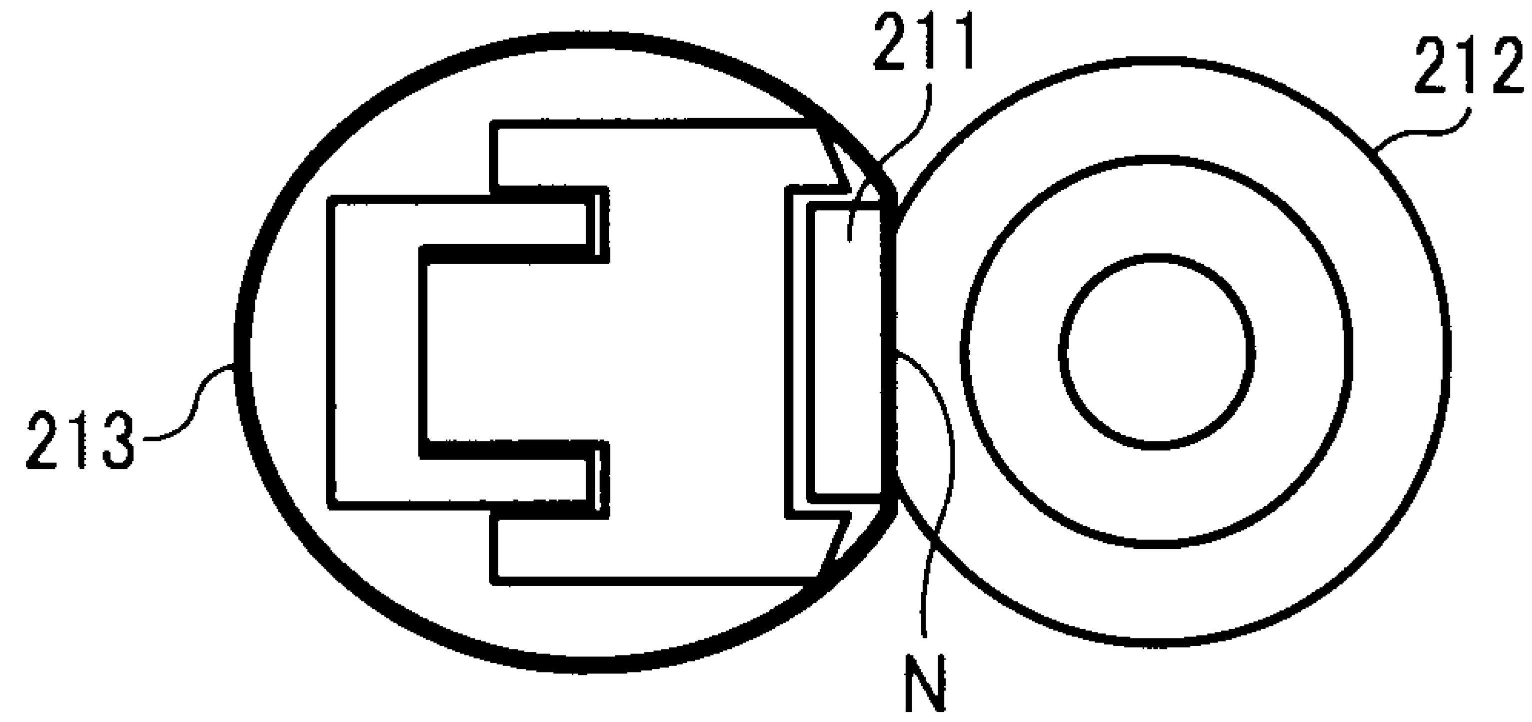


FIG. 22



FIXING DEVICE AND IMAGE FORMING APPARATUS

CROSS-REFERENCE TO RELATED APPLICATIONS

This patent application is based on and claims priority pursuant to 35 U.S.C. §119 to Japanese Patent Applications Nos. 2010-282692 and 2010-282123, filed on Dec. 20, 2010 and Dec. 17, 2010, respectively, in the Japanese Patent Office, the entire disclosures of which are hereby incorporated by reference herein.

FIELD OF THE INVENTION

The present invention relates to a fixing device fixing toner onto a recording medium with heat and pressure, and to an image forming apparatus including the fixing device, such as electrophotographic and electrostatic recording facsimile machines, printers, copiers or multifunction devices having several of these capabilities.

BACKGROUND OF THE INVENTION

Conventionally, a variety of electrophotographic image forming apparatuses are designed and known as image forming apparatuses, such as copiers and printers. The image forming process includes forming an electrostatic latent image on the surface of a photoreceptor drum as an image bearer, developing the electrostatic latent image with a developer such as toner to be visualized as toner image, transferring the toner image onto a recording medium (typically paper) with a transfer device, and fixing the toner image on the recording paper with a fixing device using pressure and heat.

In the fixing device, a fixing member and a pressure member formed of opposing rollers, belts or their combinations contact each other to form a nip. A recording paper is tucked in the nip and a toner image is fixed thereon with heat and pressure.

Japanese published unexamined application No. 11-2982 discloses using a fixing belt stretched by plural roller members as a fixing member. A fixing device using the fixing belt includes a fixing belt (an endless belt) **204**, plural rollers **202** and **203** stretching the fixing belt **204**, a heater **201** included in one of the rollers **202** and **203**, a pressure roller (member) **205**, etc. (FIG. **21**). The heater heats the fixing belt through the roller member. A toner image on a recording medium fed to a nip formed between the fixing belt and the pressure roller is fixed thereon at the nip with heat and pressure (a belt fixing method).

The fixing device may include a fixing member frictionally contacting the inner surface of the rotating fixing member. Japanese published unexamined application No. 4-44075 discloses a fixing device in which a heat-resistant film (fixing film) **213** is sandwiched between a ceramic heater **211** as a heating element and a pressure roller **212** as a pressure member **212** to form a fixing nip N, and a recording medium on which an unfixed toner image is formed is guided to the fixing nip N and transported with the film **213** to give a heat of the ceramic heater **211** and a pressure to the recording medium through the film **213** at the nip N for fixing the unfixed toner image on the recording medium with heat and pressure (FIG. **22**). The fixing device using a film heating method can form an on-demand type apparatus using a low heat capacity member for the ceramic heater and the film. Further, the ceramic heater may be energized to be heated to have a predetermined fixing temperature only when an image is formed, and a waiting time from power on to image formable status of the image forming apparatus is short (quick start) and a power consumed for standby is very small (energy saving).

Japanese published unexamined applications Nos. 8-262903 and 10-213984 disclose a fixing device using a pressure belt method, including a rotatable heat fixing roll having an elastically deformable surface; an endless belt (a pressure belt) runnable while contacting the heat fixing roll; a belt nip unrotatably located on the inside of the endless belt, contacting the endless belt to the heat fixing roll with pressure, and passing a recording paper therebetween; and a pressure pad elastically deform the surface of the heat fixing roll. This fixing method uses a belt as the pressure member below and expands a contact area of a paper and the roll to largely improve heat conduction efficiency, which enables it to reduce energy consumption and downsize the fixing device.

However, although the fixing device disclosed in Japanese published unexamined application No. 11-2982 is more suitable for higher speed printing than the apparatus using a fixing roller, it has a limit in shortening a warm-up time (a time needed for apparatus to reach a printable temperature) and a first print time (a time from receiving a printing request to paper discharge through print preparation and print operation).

On the other hand, the fixing device disclosed in Japanese published unexamined application No. 4-44075 having low heat capacity can shorten the warm-up time and the first print time, and can downsize the apparatus at the same time. However, there are problems with the durability and belt temperature stability of the fixing device. Namely, the inner surface of the belt has insufficient abrasion resistance against the ceramic heater as a heat source, and the surface becomes rough after travelling for a long time and its friction resistance increases, resulting in unstable rotation of the belt, the fixing device increases in drive torque and a the recording medium slips, resulting in image displacement, or stress on a drive gear increases, resulting in damage to the gear (problem 1).

The fixing device using a film heating method locally heating the belt only at the nip, and when the rotating belt returns to the nip, the belt has the lowest temperature, resulting in poor fixation (particularly when the belt rotates fast) (problem 2).

Japanese published unexamined application No. 8-262903 discloses a method of using a glass fiber sheet impregnated with PTFE (PTFE-impregnated glass cloth) as a low friction sheet for a surface layer of the pressure pad to improve friction between the inner surface of the belt and a fixed member. However, the fixing device using a pressure belt method disclosed in Japanese published unexamined applications Nos. 8-262903 and 10-213984 has a large heat capacity and slow in heating, resulting in long warm-up time (problem 3).

To solve the problems 1 to 3, Japanese published unexamined application No. 2007-334205 discloses a fixing device including an almost pipe-shaped opposing member (including a metallic heat conductive material, a heating member and a support member) located on the inner surface of an endless belt and a resistance heating element such as ceramic heaters located on the inner surface of the opposing member to heat the opposing member, which enables it to heat the whole fixing belt, shorten the warm-up time and the first print time and eliminate calorie shortage when the belt rotates fast.

However, the fixing device disclosed in Japanese published unexamined application No. 2007-334205 presses a pressure roller as a pressure member toward the fixing belt to form a nip, which is supported by a metallic heat conductive material. Therefore, a nip width and a pressure at the nip are unstable.

Japanese published unexamined application No. 2010-96782 discloses a fixing device including a nip forming member such as contact members and fixing members, and a reinforcing member to hold and stabilize statuses, shapes and positions of a nip between a fixing belt and pressure roller, and a pipe-shaped support member.

The support member preferably has a predetermined cross-sectional shape to perform predetermined functions, i.e., closely contacting the fixing member to heat the fixing member and ensuring separability of a recording medium. However, it is difficult to precisely maintain the external dimensions of the support member because it is made of thin sheet metal. Uneven external dimensions of the support member cause uneven performance. e.g., the fixing member and the support member do not contact each other at the downstream side of the nip and the fixing member behaves unstably, resulting in poor separability of a recording medium.

Further, even the fixing device disclosed in Japanese published unexamined application No. 4-44075 only rotating the fixing film (belt) without using a support member has a problem of unstable form of the fixing film (belt) at the exit of the nip, resulting in poor separability of a recording medium.

For these reasons, a need exists for a fixing device capable of delivering improved separability of a recording medium.

SUMMARY OF THE INVENTION

Accordingly, the present invention provides a fixing device with improved separability of a recording medium, and an image forming apparatus using the fixing device.

These objects and other objects of the present invention, either individually or collectively, have been satisfied by the invention of an improved fixing device, comprising:

a rotatable endless belt fixing member;

a pressure member located at an outer circumferential side of the fixing member, configured to contact the fixing member with pressure;

a nip forming member located at an inner circumferential side of the fixing member, configured to contact the pressure member through the fixing member to form a nip;

a reinforcing member fixed at a bore of the fixing member, configured to support the nip forming member from the opposite side of the nip;

a heating member configured to directly or indirectly heat a predetermined area of the fixing member at an upstream side of the nip; and

a flange member comprising a cylinder inserted in an inner circumference at an end of the fixing member in an axial direction thereof and configured to rotatably hold an end vicinity of the fixing member directly or indirectly by the outer circumferential surface, and a flange fixed on a frame of the fixing device,

wherein the cylinder of the flange member comprises a notch storing the nip forming member at a part on the circumference,

has an arc-shaped outer circumferential cross-section at an area corresponding to an area where the fixing member is heated by the heating member, having a predetermined radius equivalent to a radius of the fixing member, and

the arc has a center located at an upstream side in a recording medium feeding direction relative to a center line of the nip forming member in the recording medium feeding direction.

These and other objects, features and advantages of the present invention will become apparent upon consideration of the following description of the preferred embodiments of the present invention taken in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a schematic view illustrating an image forming apparatus including the fixing device of the present invention;

FIG. **2** is a central cross-sectional view illustrating a first embodiment of the fixing device of the present invention;

FIG. **3** is a central cross-sectional view illustrating decomposed support member, outer holding member and inner holding member of the first embodiment of the fixing device of the present invention;

FIG. **4** is a perspective view illustrating the support member of the first embodiment of the fixing device of the present invention;

FIG. **5** is a schematic front view illustrating sizes of the support member of the first embodiment of the fixing device of the present invention;

FIG. **6** is a perspective view illustrating a dismounted nip forming member of the first embodiment of the fixing device of the present invention;

FIG. **7** is a perspective view illustrating a backside of the nip forming member of the first embodiment of the fixing device of the present invention;

FIG. **8** is a perspective view illustrating a reinforcing member of the first embodiment of the fixing device of the present invention;

FIG. **9** is a perspective view illustrating a flange member of the first embodiment of the fixing device of the present invention;

FIG. **10** is a cross-sectional view illustrating a heater formed of a sheet heating element;

FIG. **11** is a diagram showing relationships among a perimeter difference, a frictional force and a temperature when using the support member in FIG. **5** and a fixing belt having a diameter of 30 mm;

FIG. **12** is a cross-sectional view illustrating the holding member, the flange member and a chassis plate of the first embodiment of the fixing device of the present invention;

FIG. **13** is a cross-sectional view illustrating the flange member is being inserted into the holding member;

FIG. **14** is a cross-sectional view illustrating appearance configurations of a pair of the flanges;

FIG. **15** is a perspective view illustrating details of the flange member used in the fixing device of the present invention;

FIG. **16** is a front view illustrating a shape and sizes of a cylinder of the flange member in FIG. **15**;

FIG. **17** is a front view illustrating the holding member is fitted in the flange member;

FIG. **18** is a cross-sectional view illustrating a detailed configuration of the nip forming member of the first embodiment of the fixing device of the present invention;

FIG. **19** is an explanation drawing for setting the shape of the nip forming member in FIG. **18**;

FIG. **20** is a central longitudinal sectional view illustrating a second embodiment of the fixing device of the present invention;

FIG. **21** is a schematic view illustrating a fixing device using a conventional belt fixing method; and

FIG. **22** is a schematic view illustrating a fixing device using a conventional film heating method.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a fixing device improved in separability of a recording medium.

More particularly, the present invention relates to a fixing device, comprising:

a fixing member, which is a rotatable endless belt;

a pressure member located at an outer circumferential side of the fixing member, configured to contact the fixing member with pressure;

a nip forming member located at an inner circumferential side of the fixing member, configured to contact the pressure member through the fixing member to form a nip;

a reinforcing member fixed at a bore of the fixing member, configured to support the nip forming member from the opposite side of the nip;

a heating member configured to directly or indirectly heat a predetermined area of the fixing member at an upstream side of the nip; and

a flange member comprising a cylinder inserted in an inner circumference at an end of the fixing member in an axial direction thereof and configured to rotatably hold an end vicinity of the fixing member directly or indirectly by the outer circumferential surface, and a flange fixed on a frame of the fixing device,

wherein the cylinder of the flange member comprises a notch storing the nip forming member at a part on the circumference,

has an arc-shaped outer circumferential cross-section at an area corresponding to an area where the fixing member is heated by the heating member, having a predetermined radius equivalent to a radius of the fixing member, and

the arc has a center located at an upstream side in a recording medium feeding direction relative to a center line of the nip forming member in the recording medium feeding direction.

FIG. **1** is a schematic view illustrating an image forming apparatus including the fixing device of the present invention.

An image forming apparatus **1** is a tandem color printer. Four toner bottles **102**Y, **102**M, **102**C and **102**K for each color (yellow, magenta, cyan and black) are detachably set in a bottle deck **101** located above the image forming apparatus **1**. Therefore, the four toner bottles **102**Y, **102**M, **102**C and **102**K are exchangeable by a user.

An intermediate transfer unit **85** is located below the bottle deck **101**. Image forming units **4**Y, **4**M, **4**C and **4**K for each color (yellow, magenta, cyan and black) are located in line facing an intermediate transfer belt **78** of the intermediate transfer unit **85**.

The image forming units **4**Y, **4**M, **4**C and **4**K include photoreceptor drums **5**Y, **5**M, **5**C and **5**K, respectively. Around each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K, a charger **75**, an image developer **76**, a cleaner **77** and an illustrated discharger are located. On each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K, image forming processes, i.e., a charging process, an irradiation process, a developing process, a transfer process and a cleaning process are made to from each color image on each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K.

Each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K is rotationally driven by an unillustrated drive motor clockwise in FIG. **1**. The surface of each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K is uniformly charged at a position of the charger **75** (charging process). Then, the surface of each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K reaches an irradiated position of a laser beam emitted from an irradiator **3**, where an electrostatic latent image for each color is formed by irradiation scanning (irradiation process).

Then, the surface of each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K reaches a position facing the image developer **76**, where the electrostatic is developed to form each color toner image (developing process). Then, the surface of each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K reaches a position facing the intermediate transfer belt **78** and first transfer bias rollers **79**Y, **79**M, **79**C and **79**K, where the toner image on each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K is transferred onto the intermediate transfer belt **78** (first transfer process). At that time, an untransferred toner slightly remains on each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K.

Then, the surface of each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K reaches a position facing the cleaner **77**, where the untransferred toner remaining on each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K is mechanically collected by a cleaning blade of the cleaner **77** (cleaning process).

Finally, the surface of each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K reaches a position facing the unillustrated discharger, where a residual potential on each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K is removed. Thus, a series of image forming processes made on each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K is completed.

Each toner image formed on each of the photoreceptor drums is overlappingly transferred onto the intermediate transfer belt **78**. Thus, a color image is formed thereon. The intermediate transfer unit **85** includes the intermediate transfer belt **78**; the four first transfer bias rollers **79**Y, **79**M, **79**C and **79**K; a second transfer backup roller **82**; a cleaning backup roller **83**; a tension roller **84**; an intermediate transfer cleaner **80**, etc. The intermediate transfer belt **78** is stretched and supported by the three rollers **82** to **84** and is endlessly transferred by rotary drive of the roller **82** in an arrow direction in FIG. **1**.

Each of the four first transfer bias rollers **79**Y, **79**M, **79**C and **79**K sandwiches the intermediate transfer belt **78** with each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K to form a first transfer nip. A transfer bias having a polarity reverse to that of toner is applied to each of the first transfer bias rollers **79**Y, **79**M, **79**C and **79**K. The intermediate transfer belt **78** travels in an arrow direction and passes through the first transfer nip of each of the first transfer bias rollers **79**Y, **79**M, **79**C and **79**K. Thus, each color toner image on each of the photoreceptor drums **5**Y, **5**M, **5**C and **5**K is overlapping first transferred onto the intermediate transfer belt **78**.

Then, the intermediate transfer belt **78** each color toner image is overlappingly transferred on reaches a position facing a second transfer roller **89**, where the second transfer backup roller **82** sandwiches the intermediate transfer belt **78** with the second transfer roller **89** to form a second transfer nip. A four-color toner image formed on the intermediate transfer belt **78** is transferred onto a recording medium P fed to the second transfer nip. Then, toner having not been transferred onto the recording medium P remains on the intermediate transfer belt **78**. The intermediate transfer belt **78** reaches a position of the intermediate transfer cleaner **80**, where the untransferred toner on the intermediate transfer belt **78** is collected. Thus, a series of transfer processes made on the intermediate transfer belt **78** are completed.

The recording medium P fed to the second transfer nip is from a paper feeder **12** located at the bottom of the apparatus **1** through a paper feed roller **97** and a registration roller **98**.

Plural recording media P such as transfer papers are overlappingly stored in the paper feeder **12**. When the paper feed roller **97** is rotationally driven anticlockwise in FIG. **1**, the uppermost recording medium P is fed between a pair of the registration rollers **98**.

The recording medium P fed by the pair of the registration roller **98** stops at a roller nip thereof having stopped rotary drive. The pair of the registration roller **98** is rotationally driven in timing for a color image on the intermediate transfer belt **78** to feed a recording medium P to the second transfer nip. Thus, a desired color image is transferred onto the recording medium P.

The recording medium P the color image is transferred on at the second transfer nip is fed to a fixing device **20**, where the color image is fixed by a fixing sleeve **21** and a pressure roller **31** on the recording medium P with heat and pressure. Then, the recording medium P is discharged out of the apparatus between a pair of paper discharge rollers **99**. The recording medium P discharged out of the apparatus by the pair of the paper discharge rollers **99** is sequentially stacked on a stack **100** as an output image. Thus, a series of image forming processes in the image forming apparatus **1** are completed.

Next, the fixing device **20** of the present invention is explained.

First Embodiment

As FIG. **2** shows, the fixing device **20** includes a rotatable and flexible endless fixing belt **21**, a pressure member **31** located outside in a radial direction of the fixing belt **21** and pressing inside in a radial direction thereof, a nip forming member **26** located inside in a radial direction of the fixing belt **21** and pressing the pressure member **31** each other through the fixing belt **21**, a nip **27** sandwiching a recording medium P bearing toner image T between the fixing belt **21** and the pressure member **31**, a tube-shaped (almost cylindrical or pipe-shaped) support (heat) member **60** located in the inner circumference of the fixing belt **21** and rotatably supporting the fixing belt **21**, a heater **25** heating the support member **60** to transfer heat to the fixing belt **21**, a reinforcing member **23** having the image forming apparatus **1** support the support member **60**, a flange member **28** located at both ends in a longitudinal direction of the fixing device **20**, and a chassis plate **42** supporting each of the flange members **28** in FIG. **12**.

The fixing belt **21** includes a cylindrical iron substrate **21***a* having an inner diameter of 30 mm and a thickness of from 30 to 50 μm, a release layer **21***b* formed on the outer surface of the substrate and a coated film **21***c* formed on the inner surface thereof. An elastic layer formed of a silicone rubber having a thickness of from 100 to 300 μm is formed between the substrate **21***a* and the release layer **21***b*.

A material forming the substrate **21***a* is not limited to iron, and heat conductive metallic materials such as cobalt, nickel, stainless or their alloys, or synthetic resins such as polyimide resins can be used.

The release layer **21***b* is formed to increase releasability from toner image T on a recording medium P. The release layer **21***b* is formed of PFA (tetrafluoroethylene-perfluoroalkylvinylether copolymer resin) having a thickness of from 10 to 50 μm. A material forming the release layer **21***b* is not limited to PFA, and PTFE (polytetrafluoroethylene resin), polyimide, polyetherimide, PES (polyether sulfide), etc. can be used. The release layer **21***b* is formed to assure releasability from toner image T.

The coated film **21***c* is formed to reduce friction resistance with the support member **60**. The coated film **21***c* is formed of TEFLON (registered trademark). A material forming the coated film **21***c* is not limited to TEFLON, and surface coatings such as plating, DLC (diamond-like carbon) and glass coat can be used.

The support member **60** is, as FIGS. **3** to **5** show, a metallic such as iron pipe having thickness of 0.1 to 1 mm and nearly a C-shaped cross-section. The support member **60** includes a nip concave **61** retracting the nip forming member **26** to form a part of the nip **27**, an introduction area **62** continuously located at an upstream side of the nip concave **61** in a rotational direction of the fixing belt **21**, a heated area **63** continuously located next to the introduction area **62**, a separation area **64** formed at a downstream side of the nip concave **61** in a rotational direction of the fixing belt **21**, a flat escape area **65** continuously located next to the separation area **64** and an intermediate area **66** continuously located at a downstream side of the flat escape area **65** in a rotational direction of the fixing belt **21** and continuously located next to the heated area **63**. The support member **60** is formed by press molding.

The heated area **63** has the shape of an arc having a radius of 14.5 mm, continuously located from the nip concave **61** in a rotational direction of the fixing belt **21**, and is heated by the heater **25**. An arc center **63***a* of the heated area **63** is separate from a center line **26***c* of a recording medium feeding direction of the nip forming member **26** (a white arrow in FIG. **2**) by 3.4 mm toward the upstream of the recording medium feeding direction. Therefore, the fixing belt **21** is drawn downstream in the recording medium feeding direction, and is difficult to separate from the heated area **63**. The support member **60**, particularly the heated area **63**, has a black-coated inner surface. Therefore, the heater **25** improves in radiation factor of its radiation heat.

The introduction area **62** is formed to have a distance less than the radius of the heated area **63**, i.e., 14.5 mm from the arc center **63***a* thereof. Namely, the introduction area **62** has a flat form having a small curvature, and continuously connects the nip concave **61** to the heated area **63**. This prevents the fixing belt **21** from floating from the support member **60** near the nip **27**.

The separation area **64** has an arc-shaped cross-section having a radius of 13 mm which is smaller than that of the heated area **63**, i.e., 14.5 mm, where the fixing belt **21** is quickly separated from a recording medium P having passed through the nip **27**. An arc center **64***a* of the separation area **64** separates from the arc center **63***a* of the heated area **63** downstream in the recording medium feeding direction by 2.7 mm and toward the nip **27** by 2 mm. A maximum outer diameter **18** passing the arc center **63***a* of the heated area **63** and the arc center **64***a* of the separation area **64** is a maximum outer diameter of the support member **60**, which is 30.86 mm long and longer than the inner diameter (30 mm) of the fixing belt **21**. Therefore, the fixing belt **21** is drawn between the heated area **63** and the separation area **64** and is difficult to separate from the heated area **63**. Further, L2-L1 is 0.7 mm when L1 is an outer circumferential length of the support member **60** including the nip forming member **26** and L2 is an inner circumferential length of the fixing belt **21**.

The intermediate area **66** has an arc-shaped cross-section having the same radius and the same center **63***a* as those of the heated area **63**. Therefore, the heated area **63** and the intermediate area **66** can be formed at the same curvature, and the support member **60** can easily be modified.

The escape area **65** is a flat surface separate from the arc center **64***a* of the separation area **64** downstream in the recording medium feeding direction by 11.5 mm, and is formed between the intermediate area **66** and the separation area **64**. Therefore, the support member **60** does not contact the fixing belt **21** in the escape area **65**, and the friction resistance decreases.

As FIG. **2** shows, the support member **60** has an outer surface applied with a coated film **60***a*. The coated film **60***a* is formed to reduce friction resistance with the fixing belt **21**. The coated film **60***a* is formed of TEFLON. A material forming the coated film **21***c* is not limited to TEFLON, and surface coatings such as plating, DLC (diamond-like carbon) and glass coat can be used. Further, grease is coated between the support member **60** and the fixing belt **21**, which reduces friction resistance therebetween.

As FIG. **3** shows, the nip concave **61** includes a pair of side walls **67** parallely extending to the inner side of the support member **60**, a bottom wall **68** connecting the ends of the side walls **67** and an opening **69** formed on the bottom wall **68**. The nip concave **61** is equipped with an outer holding member **70** having the shape of nearly U outside, i.e., at the inner side of the support member **60**, and an inner holding member **71** having the shape of nearly U inside, i.e., at the outer side of the support member **60**. The outer holding member **70** and the inner holding member **71** are threadably mounted, sandwiching the side walls **67** and the bottom wall **68** of the nip concave **61** in the support member **60**. The outer holding member **70** and the inner holding member **71** maintain the shape of the nip concave **61**. The outer holding member **70** has attaching portions **70***a* at both ends in a longitudinal direction. The attaching portions **70***a* are fixed on the support member **60** with the flange members **28**.

As FIGS. **2**, **6** and **7** show, the nip forming member **26** is located at the inner side of the inner holding member **71**. The nip forming member **26** is formed of a heat-resistant resin such as LCP (liquid crystal polymers), polyimide resins and PAI (polyamide-imide resins), and nearly a square bar along a longitudinal direction of the support member **60**. The nip forming member **26** includes a main body **26***a* facing the pressure member **31**, a support projection **26***b* contacting the reinforcing member **23** to be supported at the back of the main body **26***a* and a film member **29** on the circumference of the main body **26***a*.

When the main body **26***a* is pressed by the pressure member **31**, the support projection **26***b* contacted and supported by the reinforcing member **23** prevents the main body **26***a* from being pressed into by the pressure member **31**.

The nip forming member **26** has a flat surface toward the pressure member **31**, and may have a concave shape along the surface of the pressure member **31**.

The film member **29** is formed of a fabric of a PTFE fiber, and reduces friction resistance with the fixing belt **21**. The film member **29** is wound around the main body **26***a* and is fixed while sandwiched between a stopping member **19** threadably mounted near the support projection **26***b* and the main body **26***a*. The nip forming member **26** is fixed on the support member **60** with the flange members **28**.

As FIGS. **2** and **8** show, the reinforcing member **23** is a metallic and nearly square bar along a longitudinal direction of the support member **60**, and includes a main body **23***a* having high rigidity, a receiving projection **23***b* contacting the support projection **26***b* of the nip forming member **26** and a reflection board **22** facing the heater **25**. The receiving projection **23***b* contacts the support projection **26***b* of the nip forming member **26** and support the nip forming member **26** pressed by the pressure member **31** from behind. The reflection board **22** reflects radiation heat from the heater **25** and reduces heat quantity escaping to the main body **23***a* of the reinforcing member **23**. The reinforcing member **23** is fixed on the support member **60** with the flange members **28**.

The heater **25** is a linear heating element located along a longitudinal direction of the support member **60** therein, and a halogen heater in the present invention. The heater **25** is located at the inner side of the heated area **63**. Therefore, the heated area **63** is a radiated area a heat from the heater **25** is radiated to without being interrupted with the reinforcing member **23**. A temperature sensor is located at a proper position in the heated area **63** to detect a temperature of the fixing belt **21**.

As FIG. **9** shows, the flange member **28** is inserted into bores at both ends of the support member **60** in its axial direction; includes a cylinder **28***a* holding the shape near the end of the support member **60** and a flange **28***b* fixed on the chassis plate **42** of the fixing device **20**; and holds and fixes the nip forming member **26**, the outer holding member **70**, the reinforcing member **23** and the heater **25**. In addition, the flange member **28** regulates movement of the fixing belt **21** in its axial direction with a brim **28***c*.

As mentioned above, the support member **60** has a predetermined cross-sectional shape for obtaining predetermined functions such as closely contacting the fixing belt **21** at the heated area **63** to efficiently heat the belt and separability with a recording medium P at the separation area **64**, but tends to have uneven processed shapes or deform due to friction with the fixing belt **21** and lose initial functions because of a thin metallic pipe. The outer circumference of the cylinder **28***a* of the flange member **28** holds the shape near the end of the support member **60** as mentioned above to stably obtain the initial functions (details are mentioned later). Therefore, a clearance between the outer circumferential surface of the cylinder **28***a* and an inner circumferential surface at the end of the support member **60** is not greater than 0.15 mm.

The pressure member **31** is a pressure roller having an outer diameter of 30 mm, and includes a metallic pipe-shaped central shaft **32**, an elastic layer **33** formed of a heat-resistant silicone rubber around the shaft and a release layer **34** formed of PFA on the surface. The elastic layer **33** has a thickness of from 2 to 4 mm. The release layer **34** is a PFA tube having a thickness. The central shaft **32** may include a heating element such as halogen heaters when necessary.

The pressure member **31** is pressed by an unillustrated pressurizer toward the nip forming member **26** through the fixing belt **21**. When the pressure member **31** is pressed to the nip forming member **26** through the fixing belt **21** to from the nip **27**. The pressure member **31** is rotated by an unillustrated driver while pressing the fixing belt **21** (in an arrow direction in FIG. **2**). With the rotation, the fixing belt **21** rotates and a recording medium P is transferred while pressurized at the nip **27**.

Next, an operation is explained.

A user requests for printing by operating an operation panel or a computer.

When the image forming apparatus receives an output signal through this printing request, the pressure member **21** is rotated by a driver and the fixing belt rotates therewith.

The arc center **63***a* of the heated area **63** is located upstream in the recording medium feeding direction relative to a central line of a recording medium feeding direction of the nip forming member **26**, and the fixing belt **21** is drawn downstream in the recording medium feeding direction, i.e., to the opposite side of the heated area **63**. Therefore, the support member **60** contacts the fixing belt **21** closer at the heated area **63** and the fixing belt **21** is difficult to leave from the support member **60**. The heated area **63** has the shape of an arc having a radius of 14.5 mm as a cross-sectional shape, which is almost same as that of the fixing belt **21** having a radius 15 mm. Therefore, the support member **60** contacts the fixing belt **21** closer, applying almost no deformation force thereto at the heated area **63**. Further, a maximum outer diameter **18** of 30.86 mm between the heated area **63** and the separation area **64** is larger than the inner diameter of 30 mm of the fixing belt **21**, and the fixing belt **21** is drawn between the heated area **63** and the separation area **64**. Therefore, the support member **60** contacts the fixing belt **21** closer at the heated area **63** and the fixing belt **21** is difficult to leave from the support member **60**. This is why the fixing belt **21** closely slides on the support member **60** at the heated area **63**.

Meanwhile, the heater **25** produces heat when applied with current in synchronization with rotation of the pressure member **31**. The heat of the heater **25** is radiated to the heated area **63** to be quickly heated. The rotation of the pressure member **31** and heating of the heater **25** do not necessarily start at the same time, and may have a time difference. The temperature sensor detects a temperature of the fixing belt **21**, the nip **27** is heated to have a temperature needed to fix, and recording media P start rotation while the temperature is maintained. Toner image on a recording medium P having passed the nip **27** is fixed thereon with pressure and heat at the nip **27**.

An mentioned above, in the image forming apparatus of the present invention, the support member **60** contacts the fixing belt **21** closer at the heated area **63** and the fixing belt **21** is difficult to leave from the support member **60**. Therefore, a heat conductivity from the support member **60** to the fixing belt **21** increases to prevent the support member **60** from being overheated and the coated films **60***a* and **21***c* from deteriorating. Further the support member **60** contacts the fixing belt **21** closer to shorten a warm-up time and a first print time, and improve energy efficiency.

In the present invention, the separation area **64** has the shape of an arc having a radius smaller than that of the heated area as a cross-sectional shape, and the fixing belt **21** is quickly separated from a recording medium P. Therefore, separability of a recording medium P improves after passing the nip **27**.

In the present invention, L**2**-L**1** is from 0.5 to 0.9 mm when the support member **60** including the nip forming member **26** has an outer circumferential length L**1** and the fixing belt **21** has an inner circumferential length L**2** (FIG. **11**). When greater than 0.9 mm, the fixing belt **21** is loosely wound around the support member **60** to partially be overheated, resulting in deterioration of durability of the coated film. When less than 0.5 mm, the fixing belt **21** is tightly wound around the support member **60** and a frictional force therebetween becomes so large that the fixing belt **21** is difficult to rotate. In addition, the pressure member **31** and a recording medium P become easy to slip on the fixing belt **21**. Therefore, when L**2**-L**1** is from 0.5 to 0.9, the fixing belt **21** does not float free of the support member **60**, which prevents the support member **60** from being overheated. Further, the fixing belt **21** is not so tightly wound around the support member **60**, which prevents a recording medium P from slipping.

In the present invention, the fixing belt **21** is drawn between the heated area **63** and the separation area **64**, and the support member **60** contacts the fixing belt **21** closer at the heated area **63** even when the fixing belt **21** stops. Therefore, when the fixing belt **21** is heated still, it is efficiently heated without overheating the support member **60**.

Further, in the present invention, the heater **25** is a linear heating element along the support member **60**, located internally therein, and the fixing device **20** can be simplified because the linear heating element has a simple mounting structure. The inner surface of the support member **60** is painted black, which improves in radiation factor therein to shorten a warm-up time and a first print time, and improve energy efficiency.

In the present invention, between the heated area **63** and the nip forming member **26**, an introduction area **62** is located at a distance less than 14.5 mm which is a radius of the heated area **63** from the center of the arc **63***a* of the heated area **63** as a cross-sectional shape, which prevents the fixing belt **21** from floating out of an outer surface of the support member **60** and the support member **60** from being overheated.

In the present invention, the intermediate area **66** has the shape of an arc having same radius and the same center **63***a* as those of the heated area **63** as a cross-sectional shape, and the heated area **63** and the intermediate area **66** can be formed at the same curvature. Therefore, the support member **60** can easily be processed, which reduces production cost.

Further, in the present invention, the flat escape area **65** is located between the intermediate area **66** and the separation area **64**, and the support member **60** and the fixing belt **21** do not contact each other in the flat escape area **65**. A friction resistance therebetween decreases to be further smaller than that between the fixing belt **21** and a recording medium P, which prevents a recording medium P from slipping on the fixing belt **21**. In addition, a material for forming the support member **60** can be shortened, which reduces material cost.

In the present invention, the inner surface of the fixing belt **21** and an outer surface of the support member **60** are both coated with coated films **21***c* and **60***a*, respectively, and grease is applied therebetween. A friction resistance at a sliding part therebetween decreases to be smaller than that between the fixing belt **21** and a recording medium P, which prevents a recording medium P from slipping on the fixing belt **21**.

In the image forming apparatus of the present invention, L**2**-L**1** is 0.7 mm when the support member **60** including the nip forming member **26** has an outer circumferential length L**1** and the fixing belt **21** has an inner circumferential length L**2**, but which is not limited to this.

Namely, when greater than 0.9 mm, the fixing belt **21** is loosely wound around the support member **60** to partially be overheated, resulting in deterioration of durability of the coated film. When less than 0.5 mm, the fixing belt **21** is tightly wound around the support member **60** and a frictional force therebetween becomes so large that the fixing belt **21** is difficult to rotate. In addition, the pressure member **31** and a recording medium P become easy to slip on the fixing belt **21**.

Therefore, L**2**-L**1** is preferably from 0.5 to 0.9 mm, more preferably from 0.6 to 0.8 mm, and most preferably 0.7 mm, which prevents the support member **60** from being overheated and a recording medium P from slipping. However, L**2**-L**1** is not limited to 0.5 to 0.9 mm and can properly be determined according to whether the coated films **21***c* and **60***a* or grease is coated, or shapes and sizes of the components.

In the image forming apparatus of the present invention, the intermediate area **66** of the support member **60** of the fixing device **20** has the shape of an arch having the same radius and the same center **63***a* as those of the heated area **63** as a cross-sectional shape. However, the intermediate area **66** is not limited thereto, and may have a distance from the center of the arc **63***a* of the heated area **63** smaller than the radius thereof unless interfering with the reinforcing member **23**. In the intermediate area **66**, the support member **60** and the fixing belt **21** do not contact each other. A friction resistance therebetween decreases to be further smaller than that between the fixing belt **21** and a recording medium P, which prevents a recording medium P from slipping on the fixing belt **21**. In addition, a material for forming the support member **60** can be shortened, which reduces material cost.

In the image forming apparatus of the present invention, the fixing belt **21** of the fixing device **20** has a diameter of 30 mm. However, the diameter is not limited thereto and may be from 15 to 120 mm, and preferably be 25 mm.

Further, in the image forming apparatus of the present invention, the heater **25** of the fixing device **20** is a linear heating element such as halogen heaters. However, the heater is not limited thereto, and may be a sheet heating element along a longitudinal direction of the support member **60**, contacting the inner surface thereof as shown by virtual lines in FIG. **2**.

The sheet heating element, e.g., as FIG. **10** shows, includes a flexible heating sheet **52*s*** having a predetermined width and length according to an axial direction and a circumferential direction of the fixing belt **21**. The heating sheets **52*s*** includes an insulative base layer **52*a***, a resistance heating layer **52*b*** in which an electroconductive particulate material is dispersed in a heat resistant resin, and an electrode layer **52*c*** providing an electric power to the resistance heating layer **52*b***. An insulative layer **52*d*** insulating interfaces between the resistance heating layer **52*b*** and the adjacent electrode layer **52*c***, and the flexible heating sheet **52*s*** and the outside is located. The sheet heating element is connected to the electrode layer **52*c*** at the end of the heating sheets **52*s*** and has an electrode terminal providing electric power fed from an electric supply line to the electrode layer **52*c***. The sheet heating element is not limited to have this configuration, and may have other configurations.

When the sheet heating element is used instead of the linear heating element, the heated area **63** is a contact area a heat from the heater **25** formed of the sheet heating element is conducted to. The sheet heating element can efficiently heat the support member **60** to shorten a warm-up time and a first print time, and improve energy efficiency.

Alternatively, the heater **25** may be an induction coil located at an outside or an inside of the support member **60** to inductively heat the support member **60**. In this case, the heated area **63** is a facing area inductively heated facing the heater **25**. The induction heating does not directly heat the others such as the reinforcing member **23** besides the support member **60**, and can efficiently heat the support member **60**.

EXAMPLES

Under the same above-mentioned conditions, using the support member **60** having the size and shape in FIG. **5**, various measurements were made with different differences of circumferential lengths L**2**-L**1** between the outer circumferential length of the support member **60** including the nip forming member **26** L**1** and the inner circumferential length of the fixing belt **21** L**2**. The measurements were made on a relation between the difference of circumferential length and a surface temperature of the support member **60**, and a relation between the difference of circumferential length and frictional forces of the support member **60** and the fixing belt **21**.

The results are shown in FIG. **11**. As FIG. **11** shows, when the difference of circumferential length was greater than 0.9 mm, the surface temperature of the support member **60** was over a predetermined limit value. It was assumed this is because the fixing belt **21** is loosely wound around the support member **60** and floats, and the support member **60** is partially overheated. Therefore, it was proved that the coated film **60*a*** is likely to deteriorate in durability when the support member **60** is overheated.

When the difference of circumferential length is less than 0.5 mm, a frictional force between the support member **60** and the fixing belt **21** was over a predetermined limit value. Namely, it was assumed that this is because the fixing belt **21** is tightly wound around the support member **60** and a frictional force therebetween becomes so large that a slip value between the pressure member **31** and a recording medium P was over the limit. It was proved that the fixing belt **21** is difficult to rotate and the pressure member **31** and a recording medium P become easy to slip on the fixing belt **21**.

Base on these results, it was proved that the difference of circumferential length between the inner circumferential length of the fixing belt **21** and the outer circumferential length of the support member **60** is preferably 0.5 to 0.9 mm, more preferably from 0.6 to 0.8 mm, and most preferably 0.7 mm. This was proved to prevent a recording medium P from slipping while prevent the support member **60** from being overheated.

Meanwhile, the flange member **28** is inserted and fixed in bores at both ends of the support member **60** in an axial direction thereof; and holds the nip forming member **26**, the outer holding member **70**, the reinforcing member **23** and the heater **25**. Further, the fixing belt is rotatably mounted on an outer circumference of the support member **60**. A component including these members is detachable from the chassis plate **42** of the fixing device **20**, and called a fixing belt unit.

The fixing belt unit is composed as follows (ref. FIG. **13**).

(S**11**) First, the cylinder **28*a*** of the flange member **28** is inserted into a bore of an end (right end in FIG. **13**) of the support member **60** equipped with the outer holding member **70** and the inner holding member until the brim **28*c*** of the cylinder **28*a*** contacts the end of the support member **60**.

(S**12**) Next, the fixing belt **21** is mounted on the outer circumference of the support member **60**, and the nip forming member **26** is inserted into the nip concave **61** of the support member **60** until an end of the nip forming member **26** contacts a predetermined position of the flange **28*b***. The reinforcing member **23** and the heater **25** are inserted into a bore of the support member **60** until their ends contact a predetermined position of the flange **28*b*** (omitted in FIG. **13**).

(S**13**) Finally, the cylinder **28*a*** of the other flange member **28** is inserted into a bore of the other end (left end in FIG. **13**) of the support member **60** until the brim **28*c*** of the cylinder **28*a*** contacts the end of the support member **60** to complete the fixing belt unit.

The flange members **28** used in the fixing device **20** have the same sized and mirror image (symmetrical) shapes as FIG. **14** shows.

Then, the flanges **28*b*** of the flange members **28** at both ends of the fixing belt unit are fixed on predetermined positions of a pair of the chassis plates **42**, respectively to install the fixing belt unit.

As mentioned above, the support member **60** has a predetermined cross-sectional shape for obtaining predetermined functions such as closely contacting the fixing belt **21** in the heated area **63** to efficiently heat the fixing belt **21**, and assuring separability of a recording medium P in the separation area **64**. The support member **60** is prepared by pressing a thin metallic plate such as stainless having a thickness of 0.1 mm, and external dimensions were difficult to precisely maintain. Uneven sizes of the support member **60** caused uneven performance thereof. Particularly, when the maximum outer diameter **18** in FIG. **5** of 30.86 mm became shorter by a certain level, the fixing belt **21** and the support member **60** did not contact each other at a downstream side of the nip, and the fixing belt **21** unstably moved, resulting in deterioration of the separability of a recording medium P and a local float of the fixing belt **21**. Further, when the fixing belt **21** rotated, the position of the support member **60** shifted by a friction with the rotation thereof.

The present inventors keenly studied such that the flange member **28** holding both ends of the support member **60** should stabilize the shape thereof, movement thereof when the fixing belt is driven, and the shape of the fixing belt **21** to find the present invention.

Hereinafter, main configurations of the present invention are explained.

FIG. **15** is a perspective view illustrating configurations of the flange member **28** used in the fixing device **20** of the present invention.

As FIG. **15** shows, the flange member **28** includes a cylinder **28***a* inserted into bores at both ends of the support member **60** and holding the shape near the end of the support member **60**, a flange **28***b* fixed on the chassis plate **42** of the fixing device **20**, and a brim **28***c* which is a far end of the end of the support member **60** in an axial direction when mounted and a rest point of the fixing belt **21** when the apparatus is driven.

The cylinder **28***a* has a notch **28***a***1** for placing the nip forming member **26** and the nip concave **61** of the support member on a part of its circumference. The attaching portion **70***a* of the outer holding member **70** maintaining the shapes of the nip forming member **26** and the nip concave **61** is held by the flange **28***b*.

The cylinder **28***a* has a shape holding surface **28***a***2** holding a desired cross-sectional shape of a vicinity of the end of the support member in its axial direction in an area A at least adjacent to an entrance of the nip of the notch **28***a***1** on the outer circumference. The area A is a corresponding area (**63'** mentioned later) to the heated area **63** in the support member **60**. Therefore, the shape holding surface **28***a***2** is an outer circumferential surface precisely holding the above-mentioned predetermined shape of the heated area **63** in the vicinity of the end of the support member in its axial direction.

The end of the cylinder **28***a* in its axial direction is chamfered so as to be easily inserted into a bore of the end of the support member **60** in its axial direction.

The cylinder **28***a* has a guide **28***d* located on a part of its circumference in its axial direction and on the outer circumference thereof, and formed of an inclined surface inclining to the center of the cylinder as the guide **28***d* heads for the end of the cylinder **28***a*. The guide **28***d* enables the cylinder **28***a* of the flange member **28** to easily insert into a bore of the end of the support member **60** in its axial direction.

The guide **28***d* is preferably located in an area B besides the shape holding surface **28***a***2** on a circumference of the cylinder **28***a*. Namely, the area B is at least an area corresponding to the escape area **65** in the support member **60**, and may include a part of each of the separation area **64** and the intermediate area **66**. The guide **28***d* is located at a downstream side of the nip in a rotational direction of the fixing belt **21** on the circumference of the cylinder **28***a*, and in an area opposite to the heater **25** through the reinforcing member **23** in FIG. **2**.

The present invention includes, as mentioned above, the nearly cylindrical support member **60** which is heated by the heater **25** at an inner circumferential side of the fixing belt **21** and frictionally contacts its outer circumferential surface to an inner circumferential surface of the fixing belt **21** to heat the belt, and supports the rotation of thereof. The flange member **28** inserts the cylinder **28***a* into an inner circumference of the support member **60** at the end thereof in its axial direction to maintain a shape near the end thereof in its axial direction by an outer circumferential surface of the cylinder **28***a*.

The cylinder **28***a* preferably has an outer circumferential shape (a cross-sectional shape of the outer circumferential surface) having almost a same shape of an inner circumference at the heated area **63** of the support member **60**, which corresponds to an area of the fixing belt **21** heated by the heater **25**, and preferably has almost same shape and sizes of the inner circumference of the support member **60** so as to maintain the above-mentioned desired shape and sizes in FIG. **5**.

Namely, the cylinder **28***a* of the flange member **28** has cross-sectional shape of its outer circumferential surface, having the shape of an arc and a predetermined radius corresponding to a radius of the fixing belt **21**, which is the area A and the corresponding heated area **63'** corresponding to an area of the fixing belt **21** heated by the heater **25**. In the present invention, the arc has nearly a same radius as that of an inner circumference of the support member **60**. The center of the arc is located at an upstream side in a recording medium feeding direction relative to the center line **26***c* of the nip forming member **26** in the recording medium feeding direction.

As the cross-sectional shape of an outer circumferential surface of the cylinder **28***a* of the flange member **28**, a nip entrance area (the corresponding heated area **63'**) preferably projects to an outer direction of the cylinder diameter more than a nip exit area (the corresponding separation area **64'**) relative to the center line **26***c* of the nip forming member **26** in the recording medium feeding direction.

Further, as the cross-sectional shape of an outer circumferential surface of the cylinder **28***a* of the flange member **28**, a corresponding flat escape area **65'** is preferably located at a downstream side in a rotational direction of the fixing belt **21** relative to the nip exit area (the corresponding separation area **64'**).

FIG. **16** is a front view illustrating a specific outer circumferential shape of the cylinder **28***a* of the flange member **28**.

As FIG. **16** shows, the cylinder **28***a* includes the notch **28***a***1** corresponding to the nip concave **61** and containing the nip forming member **26**, a corresponding introduction area **62'** continuously located at an upstream side of the rotational direction of the fixing belt **21**, a corresponding heated area **63'** continuously located to the corresponding introduction area **62'**, the corresponding separation area **64'** located at a downstream side of the rotational direction of the fixing belt **21**, the flat corresponding escape area **65'** continuously located to the corresponding separation area **64'**, and a corresponding intermediate area **66'** continuously located to the corresponding escape area **65'** at a downstream side of the rotational direction and the corresponding heated area **63'**.

The corresponding heated area **63'** has the shape of a cross-sectional arc having a radius R**1**, continuously located from an upstream side of the notch **28***a***1** in its rotational direction, and is corresponding to an area of the support member **60**, heated by the heater **25**. An arc center **63***a'* of the corresponding heated area **63'** separates from a center line **26***c'* of the notch **28***a***1** by a distance d**1** in a recording medium feeding direction, i.e., the center line **26***c* of the nip forming member **26** in the recording medium feeding direction. Thus, the corresponding heated area **63'** properly supports the heated area **63** at an end vicinity of the support member **60** in its axial direction.

The radius R**1** is, e.g., 14.3 mm and the distance d**1** is, e.g., 2.7 mm.

The corresponding introduction area **62'** is formed to have a cross-sectional shape with a distance from the arc center **63***a'* less than the radius R**1**. Namely, the corresponding introduction area **62'** has a flat shape having a small curvature and supports the introduction area **62** at an end vicinity of the support member **60** in its axial direction.

The corresponding separation area **64'** has the shape of an arc as a cross-sectional shape, having a radius R**2** less than the radius R**1**, and supports the separation area **64** of the support member **60**. Further, the corresponding separation area **64'** supports a nip exit part of the support member **60** so as not to contact the pressure roller **31** without deforming the nip exit part. An arc center **64***a*' of the corresponding separation area **64'** separates from the arc center **63***a*' of the corresponding heated area **63'** by a distance d**2** at a down stream side in a recording medium feeding direction and a distance d**3** at a side of the notch **28***a***1** (the nip **27**). Thus, a maximum outer diameter **18'** from the arc center **63***a*' of the corresponding heated area **63'** through the arc center **64***a*' of the corresponding separation area **64'** is a maximum outer diameter of the cylinder **28**A, and the maximum outer diameter **18'** (D_{18}') supports the support member **60** such that the maximum outer diameter **18** thereof is larger than the inner diameter 30 mm of the fixing belt **21**. Further, near the end of the support member **60** in its axial direction, the cylinder **28***a* supports the support member **60** such that the difference of circumferential length L**2**-L**1** is 0.7 mm when L**1** is an outer circumferential length of the support member **60** including the nip forming member **26** and L**2** is an inner circumferential length of the fixing belt **21**.

The radius R**2** is, e.g., 12.8 mm, the distances d**2** and d**3** are, e.g., 2.7 mm and 2 mm, respectively, and the D_{18}' is, e.g., 30.46 mm.

The corresponding intermediate area **66'** has the shape of an arc as a cross-sectional shape, having the same radius as that of the corresponding heated area **63'** and the same center **63***a*'.

The corresponding flat escape area **65'** is a flat surface separated from the arc center **64***a*' of the corresponding separation area **64'** by a distance d**4** at a downstream side in a recoding medium feeding direction, and is located between the corresponding intermediate area **66'** and the corresponding separation area **64'**. Thus, the corresponding flat escape area **65'** supports the support member **60** at the escape area **65** near the end of the support member **60** in its axial direction such that the support member **60** and the fixing belt **21** do not contact each other.

The distance d**4** is, e.g., 11.3 mm.

As mentioned above, in the fixing device **20** of the present invention, the cylinder **28***a* of the flange member **28**, having a predetermined shape of the outer circumferential surface, holds proper shapes of vicinities of both ends of the fixing belt **21** in its axial direction through the support member **60** as FIG. **17**, and can improve separability of a recording medium, particularly of a wide recording medium. The flange **28** does not impair preciseness of the cross-sectional shape of the support member **60**, and can stabilize the shape of the support member **60** and movement thereof when driven.

The flange member **28** is inserted into both ends of the support member **60** in its axial direction to stabilize the cross-sectional shapes thereof although it does not stabilize its central shape. However, the following three effects can be expected even when only the shapes of the ends are stabilized.

(Effect 1) Improvement of Separability of a Wide Recording Medium P Passing Near Both Ends in the Axial Direction.

When the maximum outer diameter **18** (30.86 mm) of the support member **60** becomes less beyond a specific range, the fixing belt **21** is not tightly wound and becomes loose at a downstream side of the nip and has a larger curvature, resulting in less separability of a recording medium P. Therefore, the desired shape of the support member **60** is preferably maintained. At both ends of a recording medium P in its width direction, areas toner does not adhere to as non image forming areas and easy to separate from the fixing belt **21** are present. The flange member **28** maintains the desired shapes near the both ends of the support member **60** in its axial direction to make the both ends of a recording medium P in its width direction easier to separate for improving separability. This is more effective for a wide recording medium P passing its ends in its width direction near the both ends of the support member **60** in its axial direction.

(Effect 2) Regulation of the Support Member **60** Movement when the Fixing Belt is Driven

The fixing belt **21** is driven by the pressure roller **31** at the nip **27**, and is tight at an upstream side from the nip **27** and loose at a downstream side therefrom. The support member **60** is constantly pressurized by the frictionally moving fixing belt **21** at its tight side, and is unstable in its shape and position.

In the present invention, the shape and position of the support member **60** at the tight sight of the fixing belt (upstream side from the nip) can be stabilized by the flange member **28**.

(Effect 3) Float Regulation of the Fixing Belt **21** at the End of the Support Member **60** in its Axial Direction

The fixing belt **21** is likely to float at the both ends more than the center in the axial direction. This is because it takes a certain level of time until the whole support member **60** has a uniform temperature since the support member **60** is formed of a thin metallic plate. Namely, the support member **60** has a heat expansion difference in its axial direction until the whole support member **60** has a uniform temperature. The support member **60** is positionally regulated at the end in its axial direction by the flange member **28**, and the center thereof most largely expands outside and warps. The warp is made at the center of the support member **60** in its axial direction at a side of the heated area **63**, which most largely expands and closely contacts the fixing belt **21**. Meanwhile, the end of the support member **60** in its axial direction, which is regulated by the flange member **28** does not have a warp, and the fixing belt **21** pushed by the support member **60** expanding its center is likely to float at the end.

In the present invention, the shape of the end of the support member **60** in its axial direction is held and stabilized by the flange member **28** to prevent the fixing belt **21** from floating.

In the fixing device **20** of the present invention, the nip forming member **26** includes a flat surface **26***f*, an and a projection **26***t* from an upstream side in a recording medium P feeding direction at a surface of the pressure roller **31** side as FIG. **18** shows.

The flat surface **26***f* is formed at an upstream side of the nip **27**, and a recording medium P bearing toner image is fed to the nip **27** without flexure.

In the present invention, the flat surface **26***f* has a chamfered part **26***d* of 0.5 mm at its upstream end. This prevents the fixing belt from deteriorating in its durability due to a large flexure at the upstream end of the flat surface **26***f* when an inner surface of the fixing belt **21** having rotated and frictionally contacted the support member **60** starts frictionally contacting the upstream end of the nip forming member **26**.

When the chamfered part **26***d* is not formed at the upstream end of the flat surface **26***f*, the fixing belt **21** possibly rotates with a gap between the fixing belt **21** and the support member **60** near the downstream end of thereof because there is a microscopic difference in level between an outer circumferential surface at the downstream end of the support member **60** and a surface at the upstream end of the nip forming member **26**. Therefore, the fixing belt **21** is not fully heated and rotates at the nip **27**, resulting in deterioration of heating efficiency.

When the chamfered part **26***d* is formed at the upstream end of the flat surface **26***f*, the fixing belt **21** frictionally contacts a vicinity of the downstream end of the support member **60** (introduction area **62**) located at an upstream side of the nip forming member **26**, and the nip **27** can efficiently be heated.

Next, the shapes of the projection **26***t*, the arc-shaped part **26***e* and the flat surface **26***f* are explained in more detail, referring to FIGS. **18** and **19**.

The projection **26***t* has a peak at a position separate from the downstream end of the nip **27** having a width N by a predetermined length of L**2**' at the downstream side of the nip **27** in a recording medium feeding direction. The peak of the projection is located on an arc having the same center as that of the arc-shaped part **26***e* and a radius shorter than that thereof by L**1**'.

L**1**' and L**2**' are determined as follows.

First, if L**2**' is shorter than 1 mm, the projection **26***t* contacts the pressure roller **31**. When the projection **26***t* contacts the pressure roller **31**, a part where the nip forming member **26** (specifically the arc-shaped part **26***e*) and the pressure roller **31** do not contact each other is made at an upstream side of the projection **26***t* in a recording medium feeding direction. This part has a nip pressure lower than that of a part where the nip forming member **26** and the pressure roller **31** contact each other. Therefore, a contact pressure between the fixing belt **21** and toner image T on a recording medium P is low, resulting in possible abnormal toner images fixed on thereon such as rough images.

If L**2**' is larger than 2 mm and L**1**' is larger than 0.2 mm, a recording medium having passed the nip **27** is bent by the projection **26***t* toward the pressure roller **31** and possibly wound therearound. Particularly in both side printing, when toner image T is fixed on a side of a recording medium P, the toner image T is heated and has higher viscosity when the recording medium P is fed to the nip **27** again to fix toner image T' on the other side. The toner image T having higher viscosity is fixed on the recording medium P facing the pressure roller **31**, separability between a recording medium P and the pressure roller **31** deteriorates, resulting in higher possibility that a recording medium P is wound around the pressure roller **31**.

If L**1**' is smaller than 0.1 mm, the projection **26***t* cannot fully separate a recording medium P from the fixing belt **21**, resulting in higher possibility that a recording medium P is wound around the fixing belt **21**.

Therefore, the projection **26***t* preferably has L**1**' of from 0.1 to 0.2 mm and L**2**' of from 1 to 2 mm.

The arc-shaped part **26***e* is extensively present from any positions in the nip **27** for L**2**', and has the shape of an arc having a curvature radius R of from 25 to 60 mm along an outer circumferential surface of the pressure roller **31**. In the present invention, the curvature radius R is 60 mm.

In the present invention, an upstream end of the arc-shaped part **26***e* is located at a downstream side of the center (center line **26***c*) of the nip **27** in a recording medium feeding direction. Namely, in the nip **27**, a nip width formed by the flat surface **26***f* and the pressure roller **31** is larger than that formed by the arc-shaped part **26***e* and the pressure roller **31**. However, the upstream end of the arc-shaped part **26***e* may be located at the center of the nip **27** or at an upstream side thereof.

The projection **26***t* is formed of an arc having a predetermined curvature radius contacting both of an arc of L**1**' and a line passing a downstream end of the arc-shaped part **26***e*, and which is perpendicular to a recording medium feeding direction.

In the fixing device **20**, separability improvement effects of the cylinder **28***a* of the flange member **28** and the shape of the projection **26***t* of the nip forming member **26** can reliably separate a recording medium P having passed the nip **27** from the fixing belt **21**.

Second Embodiment

Next, the second embodiment of the fixing device of the present invention is explained.

FIG. **20** is a sectional view illustrating a second embodiment of the fixing device of the present invention.

As FIG. **20** shows, compared with the first embodiment (FIG. **2**), this embodiment differs in directly inserting the cylinder **28***a* of the flange member **28** into bores at both ends of the fixing belt **21** in its axial direction to support vicinities thereof without using the support member **60**, and equals to the first embodiment in the others. The fixing belt **21** is directly heated by the heater **25** located in the bore.

The cylinder **28***a* of the flange member **28** directly supports the vicinities of both ends of the fixing belt **21** in its axial direction not through the support member **60** to hold a proper shape of at least the vicinities of both ends of the fixing belt **21** in its axial direction as it does in the first embodiment.

At least an area corresponding to an area of the fixing belt **21** heated by the heater **25** preferably has nearly the same shape of a cylindrical inner circumferential part at the heated area **63** of the support member **60** in the first embodiment, and the outer circumferential shape (cross-sectional shape of the outer circumferential surface) of the cylinder **28***a* preferably has nearly the same shape and size of the inner circumferential side of the support member **60** to hold the desired shape and size of the fixing belt **21** (FIG. **5**).

Namely, as a cross-sectional shape of the outer circumferential surface of the cylinder **28***a* of the flange member **28**, an area corresponding to an area of the fixing belt **21** heated by the heater **25** (area A and a corresponding heated area **63**') has the shape of an arc having a predetermined radius corresponding to a radius of the fixing belt **21** (in this embodiment, the shape of an arch having nearly the same radius as that of the inner circumferential side of the fixing belt **21**) and the arc has a center located at an upstream side of a central line **26***c* of the nip forming member **26** in a recording medium feeding direction.

In addition, as the cross-sectional shape of the outer circumferential surface of the cylinder **28***a* of the flange member **28**, a nip entrance area (the corresponding heated area **63**') preferably projects to an outer direction of the cylinder diameter more than a nip exit area (the corresponding separation area **64**') relative to the center line **26***c* of the nip forming member **26** in the recording medium feeding direction.

Further, as the cross-sectional shape of an outer circumferential surface of the cylinder **28***a* of the flange member **28**, a corresponding flat escape area **65**' is preferably located at a downstream side in a rotational direction of the fixing belt **21** relative to the nip exit area (the corresponding separation area **64**').

Therefore, the cylinder **28***a* of the flange member **28** in this embodiment preferably has the shape in FIG. **14** and the following sizes.

Radius R**1**: 14.5 mm

Radius R**2**: 13 mm

Distance d**1**: 3.4 mm

Distance d**2**: 2.7 mm

Distance d3: 2 mm

Distance d4: 11.5 mm

Outer diameter D_{18}': 30.86 mm

As mentioned above, in the fixing device **20** of the present invention, the cylinder **28***a* of the flange member **28**, having a predetermined shape of the outer circumferential surface, directly holds proper shapes of vicinities of both ends of the fixing belt **21** in its axial direction, and can improve separability of a recording medium, particularly of a wide recording medium.

This embodiment does not use the support member **60**, and only the effect **1** out of the 3 effects of first embodiment can be obtained therein.

The fixing device **20** of this embodiment exerts the effect of the present invention even for A3 size recording medium P, and exerts the effect more for A4 size recording medium P because the flange member **28** exerts an effect of holding the shape of the fixing belt **21** to the center thereof in its axial direction.

Additional modifications and variations of the present invention are possible in light of the above teachings. It is therefore to be understood that within the scope of the appended claims the invention may be practiced other than as specifically described herein.

What is claimed is:

1. A fixing device, comprising:

a rotatable endless belt fixing member;

a pressure member located at an outer circumferential side of the fixing member, configured to press against the fixing member;

a nip forming member located at an inner circumferential side of the fixing member, configured to contact the pressure member through the fixing member to form a nip;

a reinforcing member fixed at a bore of the fixing member, configured to support the nip forming member from the opposite side of the nip;

a heating member configured to directly or indirectly heat a predetermined area of the fixing member at an upstream side of the nip;

a flange member comprising a cylinder inserted in an inner circumference of the fixing member at an edge of the fixing member in an axial direction thereof and configured to rotatably hold an edge vicinity of the fixing member directly or indirectly with the outer circumferential surface of the cylinder, and a flange fixed on a frame of the fixing device,

wherein the cylinder of the flange member comprises a notch in the circumference configured to contain the nip forming member, and further comprises an arc-shaped outer circumferential cross-section at an area corresponding to an area where the fixing member is heated by the heating member, having a predetermined radius equivalent to a radius of the fixing member, and the arc-shaped outer circumferential cross-section has a center located at an upstream side in a recording medium feeding direction relative to a center line of the nip forming member in the recording medium feeding direction, and

wherein the fixing member is not supported beyond at least the upstream side of the nip in the direction of rotation of the fixing member, except by the flange member at the axial edge vicinity of the fixing member.

2. The fixing device of claim **1**, wherein an entrance area of the nip projects farther beyond the circumference of the cylinder of the flange member than an exit area of the nip relative to a center line of the nip forming member in the recording medium feeding direction.

3. A fixing device, comprising:

a rotatable endless belt fixing member;

a pressure member located at an outer circumferential side of the fixing member, configured to press against the fixing member;

a nip forming member located at an inner circumferential side of the fixing member, configured to contact the pressure member through the fixing member to form a nip;

a reinforcing member fixed at a bore of the fixing member, configured to support the nip forming member from the opposite side of the nip;

a heating member configured to directly or indirectly heat a predetermined area of the fixing member at an upstream side of the nip;

a flange member comprising a cylinder inserted in an inner circumference of the fixing member at an edge of the fixing member in an axial direction thereof and configured to rotatably hold an edge vicinity of the fixing member directly or indirectly with the outer circumferential surface of the cylinder, and a flange fixed on a frame of the fixing device, wherein the cylinder of the flange member comprises a notch in the circumference configured to contain the nip forming member, and further comprises an arc-shaped outer circumferential cross-section at an area corresponding to an area where the fixing member is heated by the heating member, having a predetermined radius equivalent to a radius of the fixing member, and the arc-shaped outer circumferential cross-section has a center located at an upstream side in a recording medium feeding direction relative to a center line of the nip forming member in the recording medium feeding direction,

further comprising a corresponding flat escape area located at a downstream side in a rotational direction of the fixing member relative to the exit area of the nip.

4. The fixing device of claim **1**, further comprising a substantially cylindrical support member heated by the heating member at an inner circumferential side of the fixing member and frictionally contacting its outer circumferential surface to an inner circumferential surface of the fixing member to heat the fixing member to support the rotation of the fixing member,

wherein the flange member inserts the cylinder into an inner circumference of the support member at the edge thereof in its axial direction to maintain a shape of the fixing member near the edge thereof in its axial direction with the outer circumferential surface of the cylinder of the flange member.

5. The fixing device of claim **4**, wherein the support member comprises:

a heated area located at an upstream side of the nip in a rotational direction of the fixing member and heated by the heating member;

a separation area located at a downstream side of the nip in the rotational direction of the fixing member where a recording medium is separated from the fixing member; and

an intermediate area continuously located at a downstream side of the separation area in the rotational direction of the fixing member and continuously located next to the heated area,

wherein:

the heated area has a cross-section having the shape of an arc having substantially the same radius as that of the fixing member and a center of the arc is located at an upstream side of the nip forming member in a recording medium feeding direction relative to a central line of the recording medium feeding direction;

the separation area has a cross-section having the shape of an arc, a center of the arc located at a downstream side of the recording medium feeding direction and a side of the nip relative to the center of the arc of the heated area;

a maximum outer diameter between the heated area and the separation area is a maximum outer diameter of the support member and larger than an inner diameter of the fixing member; and

at least an area corresponding to an area of the fixing member heated by the heating member has substantially the same shape of a cylindrical inner circumferential part at the heated area of the support member as a cross-section of an outer circumferential surface of the cylinder of the flange member.

6. An image forming apparatus, comprising the fixing device according to claim **1**.

* * * * *